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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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Foundry Technical Institute, Meek's Road, Falkirk (*Telephone 332*

Forthcoming Events.

APRIL 19.

Institution of Welding Engineers:—Meeting in London. "Improvements in Welding Practice," Paper by or on behalf of Prize-winner.

Institute of British Foundrymen.

APRIL 7.

Middlesbrough Branch:—Annual general meeting at Middlesbrough. Discussion and Films of Interest.

APRIL 13.

London Branch:—Ordinary meeting in London. "The Preparation of Moulding Sand," Paper by the Hon. J. M. W. North.

APRIL 15.

Lancashire Branch (Junior Section):—Ordinary meeting at Manchester. Short Paper Competition.

APRIL 21.

Sheffield and District Branch:—Annual general meeting at Sheffield. "The Technical Committee and Technical Developments in the Foundry Trade," Paper by J. R. Hyde and T. R. Walker.

APRIL 27.

Newcastle-upon-Tyne and District Branch:—Annual general meeting at Newcastle-upon-Tyne. Papers by competitors successful in the competition on January 25.

APRIL 29.

West Riding of Yorkshire Branch:—Annual general meeting at Technical College, Bradford.

Coal and Castings.—I.

A considerable amount of space has been devoted in the Press recently to the effort on the part of the coal industry, through the Coal Utilisation Council, to win back for coal so much of the market that it has lost. Everyone will follow with sympathy any efforts on the part of the coal industry to regain its former position, but there is a moral for founders in the situation. We think it would be broadly true to say that twenty years ago coal was regarded as an absolute necessity, and its cost an inevitable business expense. It was sold direct to the user, whether the industrial consumer in comparatively large quantities, or the domestic consumer in small quantities, for conversion into heat or power. Part of the work of the new body will be to convince both types of users of the particular virtues of coal and its cheapness as compared with alternative forms of heat and power now available—oil, gas and electricity. The adoption of oil by the Navy is a typical case of a valuable field entirely lost to coal, on which propaganda is to be exercised.

Doubtless the industry will have little difficulty in demonstrating that coal is the cheapest available source of heat and power, but it does not at all follow that there will be a consequent increase in coal consumption. One of the leading features of industry for the past twenty years has been an intensive effort to reduce costs, and those which were at one time treated as an inevitable business expense have been subjected to the closest scrutiny. In many works fuel engineers and fuel economists have been employed with the definite object of reducing the amount of fuel used and of utilising cheaper grades. Designers of boilers, mechanical stokers and auxiliary gear have endeavoured to make it possible to raise steam with a smaller amount of fuel and from cheaper grades. The tremendous increase in the amount of power produced is, from the coalowners' point of view, offset to some extent by the increased efficiency of prime movers, making it possible to produce power relatively more cheaply, and the coal industry has to face the fact that that consumption of coal in the past which represented wasteful and uneconomic use has gone for ever—and those who have regard to the health of our people welcome the change.

Providing a Scientific Casting.

Thinking around the technical exhibit to be staged at the forthcoming foundry exhibition, it appears to us that it would be impressive to have on show just one casting about which everything was known. Naturally it would require almost a small text-book, as it would have to contain analyses of all the raw materials used—pig-iron, scrap, coke, limestone, etc. Then there would have to be a complete history of the melting conditions, the composition of the slags and gases produced, followed by a study of the sands, including all their physical and chemical properties, together with data as to ramming conditions. Facts would have to be available as to the casting temperature and the rate of cooling of the casting, and finally the composition, mechanical properties and microstructure of the various parts.

Such a casting would be well worthy of a prominent position in the South Kensington Museum, as showing just what knowledge is available at the present time. The sample would best be taken in a quantity production plant, as many factors are there standardised and reproducible at will, whilst the possession of a large staff of metallurgists is a *sine qua non*. If such a job were undertaken, it would be as well to utilise as much of the work as possible for the provision of standards for the industry, such as slags, sands, coal dust, the metal itself, photomicrographs, and so forth.

The problem would be relatively easy if a simple non-ferrous casting were made by the crucible process, as virtually only the sands would require investigation, for in many cases all other information is readily obtainable, whilst for many die castings complete information is no doubt available. These, however, possess but little interest compared with a grey iron, or better still a malleable casting, as the majority of the variables are eliminated in die-casting manufacture. The organisation or firm which first produces an iron casting about which everything is known will indeed go down in history as a pioneer.

C

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Anti-Foundry Propaganda.

To the Editor of The Foundry Trade Journal.

Sir,—We have read with considerable surprise the appraisal of the American steel-foundry industry, as made by Mr. Yerbury and alluded to in a recent issue of your Journal. It is disconcerting to note the tendency of some tourists to become commentators on foreign institutions in the absence of the full facts. It is apparent Mr. Yerbury's reaction was formed in this way. We are not unduly exercised over what is a rather common failing among trans-oceanic visitors. Nevertheless, false summations do have some damaging effect on otherwise uninformed public opinion and certainly should be discouraged.

The fact is that the steel-foundry industry here in the United States has been making steady progress year after year. It has broadened its markets, improved its product and service and is more than holding its own in every technical and commercial phase. It has usually set the pace for all cast metals and has steadily expanded its scope. An industry that consistently produces an average of over one million tons of product per year cannot be decadent. When, with every passing year, innovations are made in analyses, melting, moulding, heat-treating, etc., the industry cannot be unprogressive.

Steel castings are constantly building a wider sphere of usefulness for themselves, and this broadening of their application promises to continue. We have plenty of competition, both inside and outside of the foundry field, but economic fitness of our product has maintained its equilibrium in the competitive scheme. Steel castings are being used to meet the most exacting service requirements, where human life rests on their absolute dependability. Day in and day out our products are adequately meeting the demands placed upon them. Soundness and integrity are evidenced by satisfactory performance. What the future holds for cast steel cannot be positively predicted, but it would be my guess that it will play an increasingly important rôle among structural materials.—Yours, etc.,

R. L. Collier.

Steel Founders' Society of America, Inc.,
932, Graybar Building, Lexington Avenue at Forty-Third Street, New York,
March 17, 1933.

Vouchers and Tickets for the Foundry Exhibition.

Messrs. F. W. Bridges & Sons, Limited, Grand Buildings, Trafalgar Square, London, W.C.2, the organisers of the International Foundry Trades' Exhibition to be held at the Agricultural Hall, London, from April 24 to May 3, have been successful in arranging with the railway companies of Great Britain for the issue of reduced fares for visitors. On application, foundrymen can receive vouchers enabling them to travel from their home towns to London and back for a fare and a-third. Moreover, tickets for free admission to the exhibition will be enclosed with each application. Visitors are reminded that the railway vouchers must be stamped at the Royal Agricultural Hall by the exhibition authorities.

American Grey-Iron Casting Specifications Standardised.

At the meeting of A.S.T.M. Committee A-3 on Cast Iron, held in New York City on March 7, in conjunction with the Group Meetings of A.S.T.M. Committees, it was voted to recommend the adoption of the Tentative Specifications for Grey-Iron Castings (A 48—32 T) as standard. It will be recalled that these specifications were formulated by Committee A-3 with the co-operation of the Grey Iron Institute, and were approved for publication as tentative at the June, 1932, meeting of the Society. These specifications, which include classifications ranging from 20,000 to 60,000 lb. per sq. in. tensile, were drawn up to supersede all individual specifications previously existing. The introduction of the specifications as tentative has already removed an element of uncertainty in buying and selling castings, and the specifications have been well received by the industry during the past year. Once they have been adopted as standard, it is expected their value to the industry will be still further increased.

The committee is continuing its work on the determination of value of additional test-bars and the method of making the bar. Members have been requested to submit data on the correlation of transverse and tension tests of the irons called for in the specifications.

For the past three years, Committee A-3, through its Sub-Committee on Impact Testing (Dr. J. T. MacKenzie, chairman), has conducted a very extensive investigation on impact testing of cast iron. Based upon a careful appraisal of the comprehensive data available, a report on this subject will be presented at the annual meeting of the Society in June.

The Committee on Cast Iron is co-operating in preparing for a Joint Symposium on Cast Iron, sponsored by the American Foundrymen's Association and the Society, which will be held at the annual meeting of the A.S.T.M. in June, Chicago. The American Foundrymen's Association and the Society are also co-operating in the holding of a Joint Symposium on Specifications and Testing of Cast Iron, which will be held at the 1933 A.F.A. meeting in Chicago. Committee A-3 is securing Papers for this meeting.

The Symposium on Specifications and Testing of Cast Iron will be held on the last day of the A.F.A. meeting, June 23, and it is expected that the Symposium on Cast Iron at the A.S.T.M. meeting will be scheduled for June 26.

Canada's Foreign Debts.

HER ABILITY TO MEET THEM.

The Royal Bank of Canada, commenting in its monthly letter for March on the report that speculation has arisen in Great Britain and the United States as to the ability of Canada to meet her foreign debt obligations, says the view generally held is that Canada is a borrower. But, as a fact, on balance over the last ten years, Canada has exported capital to an amount of 779 million dollars (over £155,000,000 at par). Even in the year that has just passed, the net export of capital is estimated at no less than 70 million dollars (£14,000,000). "Present indications strongly suggest," adds the letter, "that there will be a material increase in gold production and export during the current year, that commodity imports will be reduced, and that exports to Great Britain may show a further increase as a result of the Ottawa agreements. There should be no question of our ability to take care of all foreign obligations without any particular strain."

Random Shots.

Way down on a farm at Lyonshall (Herefordshire) a labourer was attending to the drainage of a meadow. The drain had become blocked, and when the labourer (let's call him "Jarge") was excavating the ground he found that the water was passing through "pipes" made from the horns of cattle. This primitive but effective drain extended for about a hundred yards and had been laid according to the fall of the ground. The horns were end to end, and in order that they should function properly they were placed five or six deep, so that should an obstruction occur in one "pipe" others could deal with the flow of water. On being exposed to the air the "pipes" crumbled. Much water must have flowed beneath the old mill bridge since those pipes were laid.

* * *

Remembering the cult of the antique, I think that foundrymen should prepare for a demand for "Ye olde Hornpipe" (not the nautical variety). An American who has gone to the expense of transhipping one of the stately homes in which Queen Boadicea once slept is not likely to spoil the ship for a ha'porth of tar. He will undoubtedly demand that his iron pipes be replaced by horns from cattle, preferably from real Highland cattle worth at least 600 dollars each. There will undoubtedly arise a need for a "hornpipe factory" (not the nautical variety).

* * *

A correspondent, basing his claim on a standard dictionary, has rallied to the flag of the spelling "Ferreous." We marksmen are a strong and silent race, and when we say a thing we mean it. After referring to many dictionaries, I find that the word "ferreous" is, as a rule, termed obsolete. Now, when there is a perfectly good word like ferrous at hand, why should my correspondent and the catalogue of the Birmingham section of the British Industries Fair use an obsolete one? The remainder of the phraseology of the catalogue is quite up to date. The foreword by Mr. Elliott on page 10 is written in modern English. It does not commence: "Ye first faire in ye towne of Birmingham was held in ye yeare of grace, 1920, erstwhon . . ." Those who, like the compiler of the B.I.F. catalogue, prefer the language of Chaucer, are, I suppose, at liberty to use it. They are, I suppose, at liberty to wear ruffs, powdered wigs and beaver hats. Personally, I prefer to wear plus fours and abide by the language of the twentieth century. I am less likely to be misunderstood by 'bus conductors and policemen.

* * *

Student: "Professor, I must protest at your unfair marking of my Paper. I'm sure I did not deserve an absolute zero."

Professor: "I know that also, my lad, but it's the lowest mark I'm allowed to give."

* * *

Mistress: "Mary, has the chemist sent that sleeping draft yet?"

Maid: "No, ma'am."

Mistress: "Then ring him up and ask him if he expects me to keep awake all night waiting for it."

Marksman.

Heat Losses in Furnace Operation.

CORRECT USE OF REFRACTORIES.

In the course of a Paper entitled "The Design and Operation of Industrial Furnaces using Gas, Oil and Electricity," read on March 10 by Mr. S. N. Brayshaw, M.I.Mech.E., before a meeting of the Manchester Association of Engineers, the author pointed out that whether a furnace be heated by solid, liquid or gaseous fuel, or by electricity, consideration must be given in the design, to losses through the walls by conduction, and from the surface by radiation and convection. The other chief loss common to all was through and around the door. The relative importance of each item varied according to the method of heating, but the same underlying principles applied in all cases. To illustrate

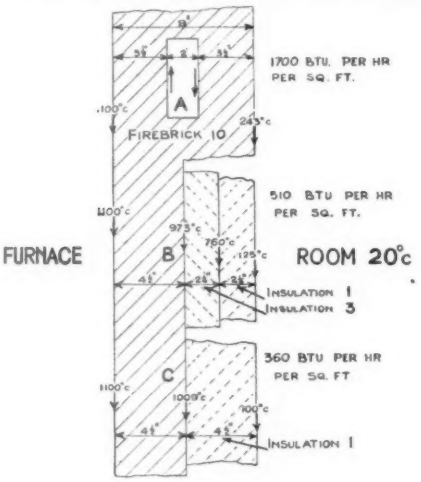


Fig. 1.

the effect of conduction through furnace walls (continued the author), some examples have been worked out on the basis of conductivities as follows:—Carborundum 70, firebrick 10, medium insulation 3, best insulation 1. These figures indicate the flow of heat in B.T.U. per hr. with a temperature gradient of 1 deg. Fah. in a thickness of one inch over an area of one square foot. Results have been given just as calculated, but it must be understood that in practice there would be a margin of variation.

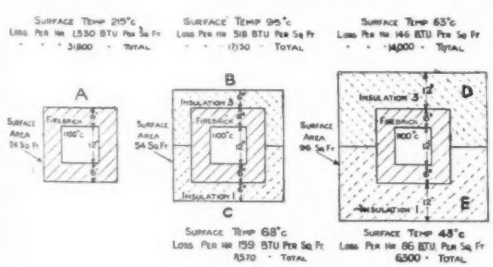


Fig. 4.

The conductivities would not be exactly even figures, and small discrepancies would arise in various ways, nevertheless, the figures are a good guide and are sufficiently accurate to illustrate the principles of conduction.

Fig. 1 shows a furnace wall 9 in. thick, with a firebrick face at a temperature of 1,100 deg. C. Without insulation the temperature on the outside of the wall in a room at 20 deg. C. would be 243 deg. C., and the loss per square foot would be 1,700 B.T.U. per hr. Cavities are sometimes built in walls, as shown at A, to break the flow of heat, but they are rarely beneficial and may be harmful because convection currents are set up, as shown by the arrows, and these carry the heat across the gap.

A cavity in a good conductor retards the transfer because the convection currents cannot carry the heat so rapidly as the speed with which it would pass through the solid material, but a cavity in insulating material assists the flow by the comparatively swift transfer effected by convection. From this it would appear an easy matter to calculate the degree of conductivity at which the transfer of heat by convection balances the heat conducted through the solid. It would then follow that cavities should be used in materials with a higher conductivity than the figure so calculated and not used in materials with a lower conductivity, but the problem is not so simple as this. The position

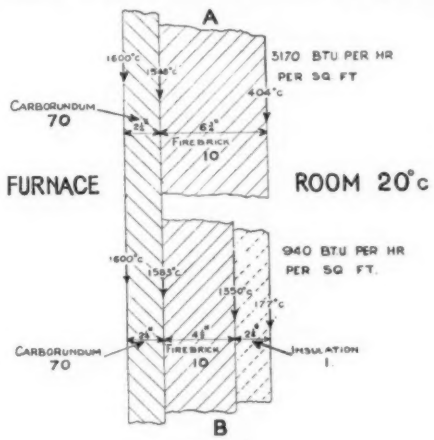


Fig. 2.

of the cavity is an important factor as will be shown later, and the nature of the cavity itself must be considered. If the cavity shown at A (Fig. 1) were rounded at the top and bottom the velocity of the convection currents would be increased, which would assist in the transfer of heat, also a rough surface gives and receives less heat than a smooth one, so far as convection is concerned.

As the loss through 9 in. of firebrick is considerable, it is advisable to insulate the outer surface, and the method of doing this is shown at B in Fig. 1. It is necessary to proceed in this way because, generally, the insulation with the lowest conductivity fails to stand up at high temperatures and loses its resistant properties,

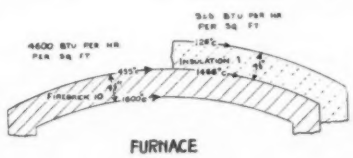


Fig. 5.

hence it is necessary in the first place to use the medium insulation, and this may be backed up by the best insulation when the temperature has fallen sufficiently. In the example given at B the face temperature of insulation 3 reaches 973 deg. C., which is not too high for a good quality of material. The effect of applying the highest insulation without an intervening layer is shown at C. The increased resistance to the passage of heat would raise the face temperature to 1,009 deg. C., with the result that the material would soon lose its valuable properties.

The saving to be effected by well-designed insulation is seen by a comparison of A and B, which shows that the loss per hour per square foot of 1,700 B.T.U. is reduced to 510 B.T.U. The extra insulation shown at C further reduces the loss to 360 B.T.U., which is interesting as showing that only a comparatively small saving could be effected by this construction, which, as shown above, is faulty, and even this saving would disappear in the first week of running owing to the deterioration of the insulation.

Fig. 2 shows a more difficult problem. The face temperature in the furnace is 1,600 deg. C., and accordingly there is a lining of carborundum backed by 10 in. of firebrick as shown at A. Carborundum is such a good conductor that the drop in temperature through 2½ in. is only slight and the outside of the brick wall reaches 400 deg. C., giving the very high loss per hour per square foot of 3,170 B.T.U. If one could imagine the wall being built as shown at B (Fig. 2) with 2½ in. of best insulation, the effect would be to push up the temperature of the firebrick to such an extent that the heat gradient through the carborundum would be reduced from about 50 to about 20 deg. C. and the face of the insulation would reach 1,350 deg. C. According to this the surface loss would fall by calculation from 3,170 to 940, but nothing of

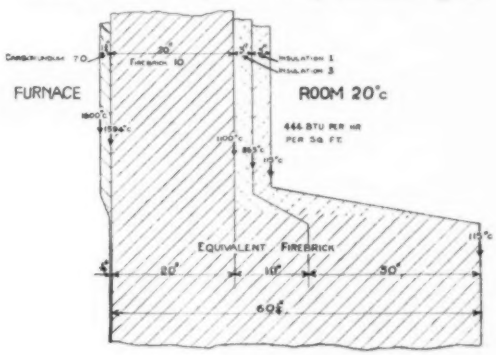
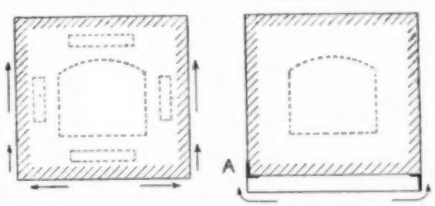


Fig. 3.

the kind could be realised in practice because long before that point was reached the insulation would fail and soon the construction shown at B would lose more heat than the one shown at A.

Further considerations concerning walls for



Temperature of Surface 360°F - 182°c
" " Room 60°F - 16°c
" " Difference 300°F - 166°c

Heat Loss BTU Per Hr. Per Sq. Ft.	Position of Surface		
	Vertical	Horizontal Top	Horizontal Bottom
By Radiation	600	600	600
" Convection	300	330	150
Total	900	930	750

Fig. 6.

high temperatures are shown in Fig. 3. A face temperature on the furnace side of 1,600 deg. C. falls to 115 deg. C. on the outer surface. The total thickness of the wall as shown is 27¾ in. and, so far as conductivity is concerned, the same result might be obtained from a wall of solid firebrick 60¼ in. thick, the 3 in. of best insulation being equal to 30 in. of firebrick, when their respective conductivities are one to ten, and so forth for each thickness of material in the wall. The 28-in. wall and the 60-in. wall will both have the same temperature on the outer surface and the loss per square foot will be about 444 B.T.U. per hour in each case.

This does not show that the 60-in. wall is as good as the 28-in. Apart from questions of extra cost and floor space there are two fatal objections to the retention of heat by a mere increase of brickwork. In the first place, the thicker wall absorbs a great amount of heat before a balance is reached. This would not matter in the case of a continuous furnace running for months at a time, but it would be serious if the furnace were shut down every week-end. The second objection is that, although the loss per square foot is the same in each case, the actual loss is much greater with the thicker wall due to the increase in the outside dimensions.

The effect of increasing the wall thickness is illustrated in Fig. 4, in which an imaginary furnace is shown with a chamber, measuring 1-ft. cube, maintained continuously at 1,100 deg. C. The chamber is completely enclosed by firebrick 6 in. thick, so that the outside of the firebrick forms a 2-ft. cube as shown at A. B shows the firebrick covered with 6 in. of insulation 3, C with 6 in. of insulation 1. D with 12 in. of insulation 3, and E with 12 in. of insulation 1. The outside-surface temperatures of A, B, C, D and E work out respectively as follow: 215, 95, 68, 63 and 43 deg. C.; and the losses per hour per square foot are 1,330, 318, 159, 146 and 86 B.T.U. Taken by themselves these figures are misleading. They seem to show that C with 6 in. of insulation 1 is nearly but not quite as good as D with 12 in. of insulation 3, whilst E with 12 in. of insulation 1 is apparently very much the best. The true facts emerge when account is taken of the extended surface areas. The total surface losses per hour, which are all that matter, work out as follow: 31,800, 17,150, 8,570, 14,000 and 6,300 B.T.U. It is now seen that C with its 6 in. of insulation 1 is not worse but is actually much better than D with its 12 in. of insulation 3. Furthermore, the loss of 31,800 B.T.U. from the unprotected brickwork A is reduced to 8,570 by the use of 6 in. of insulation 1, which is an enormous gain both actual and by percentage, but an increase in the thickness of the insulation from 6 in. to 12 in. only reduces the loss to 6,300, which truly is a further 26 per cent., but taking into account that this percentage is applied to a figure already very much reduced it is seen that the actual further saving is trifling.

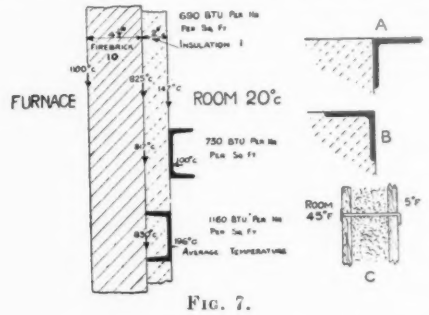


Fig. 7.

In the example given, particularly as shown in Fig. 4, it is understood that exaggerated illustrations, not to be found in actual work, have been taken as convenient bases for theoretical calculations. Also allowance has not been made for all the irregularities occasioned by the shape of the construction, but the calculated figures have a good relative value and are a useful indication of problems that frequently arise.

A decision as to the thickness and nature of the insulation depends to a large extent upon the cost of the heating. In many cases the cost even of slight insulation would not be covered by the saving of solid fuel. With gas and oil a moderate amount of insulation pays for itself, but a point is soon reached at which the saving does not justify the extra capital cost and floor space.

Fig. 5 shows a brick arch 4½ in. thick at a temperature of 1,600 deg. C. on its under side. The temperature on the top would be about 455 deg. C. and the loss by radiation and convection would reach 4,600 B.T.U. per hr. per sq. ft. An attempt to prevent this enormous heat loss by insulating the top would result in a rise in temperature sufficient to destroy the insulation in a very short time, but in even shorter time the arch would collapse. High-temperature arches maintain their form by the use of a thin layer of bricks without any covering. The addition of insulation or even of a considerable thickness of firebrick would result in a failure of the structure.

The heat is not at its journey's end when it has found its way through the furnace wall for it still has to leave the outside surface. Its departure is accomplished partly by direct radiation and partly by convection currents set up in the surrounding air. Smoothness of surface retards radiation but increases the loss by convection. Radiation is increased by painting the surface black, but it is decreased by a coating of aluminium paint. Radiation is not affected by the position of the surface but the loss by convection is much higher on a horizontal surface facing upwards than on a similar surface facing downwards.

Fig. 6 shows the action of convection currents. The air passes swiftly up the sides of a furnace carrying away the heat. Hot air passes away even more readily from the top so that the cooling effect is greater than on the sides but the flow is slower along the bottom with a correspondingly smaller loss of heat. The table shows the losses that may be expected under the conditions given, the difference in temperature between the surface and the room being 300 deg. Fah. The loss by radiation would be about 600 B.T.U. per sq. ft. irrespective of position. The loss by convection would be, on the vertical wall 300, on the top 330 and on the bottom only 150.

Convection currents carry the heat across cavities, as already explained. A cavity in the top is worse than one in the side, but a cavity in the bottom would be distinctly useful for retaining the heat because the hottest air would remain at the top, and in the absence of air currents there would be little passage of heat. The objection to the cavity in this position is that it has no carrying capacity. An angle placed as shown at A in Fig. 6 allows the hot air to flow away from the bottom of the furnace, but angles as shown at B, if continued, without a gap, all the way round, retain a pocket of hot air under the furnace with a saving of heat much greater than the loss occasioned by the extra surface of the angle exposed to the air.

In Fig 7 a top angle is shown at A turned outwards, but in this case, though it may, perhaps, retard convection to a negligible degree, the extra surface will part with appreciably more heat than can escape, under otherwise equal conditions, from an angle turned inwardly as shown at B. In Fig. 7 is also shown a vertical wall under conditions such that the temperature on the outside is 147 deg. C. and the heat loss is 690 B.T.U. per hr. per sq. ft. If against this wall a channel is fixed with the webs turned outward the increase of exposed surface will cause an appreciable increase in the heat loss, which will rise to 730 B.T.U.. whilst, and in consequence of this loss, the surface temperature will fall to 100 deg. C. The loss caused by the increase of exposed surface could be saved by turning the channel inwards as shown, but immediately conduction would come into action to such an extent that the surface temperature would rise to 196 deg. C., and at this high temperature, without increase of surface, the loss would jump to 1,160 B.T.U.

Heat losses are heavy when, as in many forging furnaces, it is necessary to work with open doorways. When doors are used, their design and construction deserve more attention than they have commonly received. With the use of electricity it is easy to introduce heating elements into the door itself and this is frequently done with great advantage. A partly-open door is shown at A in Fig. 8 in a correct position for retaining the heat as much as possible. A door which opens as shown at B forms a flue against the front of the furnace and causes an uprush of hot air or gases. A door which rests upon a platform on the same level as the furnace hearth loses much more heat than a door which completely covers the doorway with a good overlap on the bottom as well as on the sides and top. Fig. 8 also shows the well-known pear-shaped sight-hole cover and an improved cover which can be used with comfort by the operator.

The feature which distinguishes electrical furnaces from those heated by gas or oil is the absence of products of combustion. Fuel furnaces necessarily lose a great deal of heat up the flue. Electricity, without flue loss, and with the heat retained by all available means, can be used with a very much higher efficiency than any fuel furnace. The flue losses of fuel furnaces may be reduced but not eliminated and in any case it would not be desirable to recover all the heat from the waste gases.

Regarding recuperation, there is a fallacy in estimating its value by the amount of heat removed from the products of combustion. The size of the recuperator is an important factor. A large recuperator dissipates much heat in addition to that which it returns to the furnace. Furthermore, a large mass of material in the recuperator is a bad feature because it needs to be heated up before it comes into action and at the close of work the heat in the mass represents loss. This applies particularly to furnaces which are shut down every night and in a less degree to those which run continuously through the week.

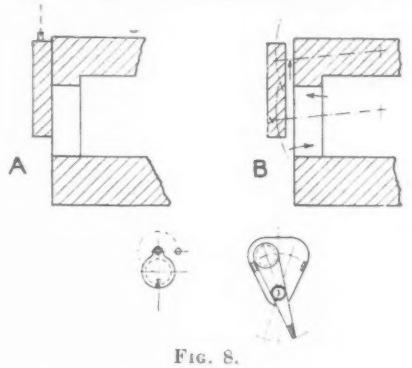


Fig. 8.

Chromium Plating.

We recently inspected the shops of Metalion, Limited, of 1, Lacland Place, Chelsea, London, S.W.10. as we had heard that Sir Malcolm Campbell had entrusted parts of the "Bluebird" to this concern and had expressed himself as being more than satisfied with the results. We had plated, whilst we were there, a piece of ½-in. steel tubing. After degreasing in caustic soda and etching in a sulphuric-acid bath, the sample was nickel plated at much higher voltage than normal. The acid bath is an important feature. It acts like sand-blasting previous to enamelling and helps to "key" the deposit to the surface. After chromium plating and buffing, the sample was heated to redness and the end closed by hammering, and whilst still red hot dipped into cold water. This sample is in front of us now, and beyond temper colours on one side it still possesses a perfectly bright, well-plated surface. Unquestionably, the firm possesses valuable experience in nickel-chromium plating and is well placed to give a useful service to the foundry industry.

The Foundry Exhibition.

It is now possible to have an appreciation of the final position of the Foundry Trades' Exhibition. The plan which we publish shows that practically all the best spaces have been taken up. Below is a list of exhibitors, from which it will be seen that pig-iron, coke, refractories, foundry machinery and scientific instruments and services are well represented.

The Exhibitors.

Sir W. G. Armstrong, Whitworth & Company (Engineers), Limited, Scotswood Works, Newcastle-upon-Tyne.

Atlas Preservative Company, Limited, Fraser Road, Erith, Kent.

August's, Limited, Thorn Tree Works, Halifax.

Bagshawe & Company, Limited, Dunstable Works, Dunstable.

The Fordath Engineering Company, Limited, Hamblet Works, West Bromwich.

General Refractories, Limited, Genefax House, Sheffield.

Thomas E. Gray & Company, Limited, 119, High Holborn, W.C.1.

Imperial Chemical Industries, Limited, Imperial Chemical House, Millbank, S.W.1.

The Foundry Trade Journal, 49, Wellington Street, W.C.2.

E. Leitz (London), 20, Mortimer Street, W.1.

The Louis Cassier Company, Limited, 22, Henrietta Street, W.C.2.

Major, Robinson & Company, Limited, "Scols" Works, 385/7, City Road, Cornbrook, Manchester.

Stewarts and Lloyds, Limited, Winchester House, Old Broad Street, E.C.2.

Welsh Navigation Steam Coal Company, Limited, Cambrian Buildings, Cardiff.

Thomas Wilkinson & Company, Limited, Stockton Street, Middlesbrough.

Tilghman's Patent Sand Blast Company, Limited, Broadheath, near Manchester.

Four Oaks Spraying Machine Company, Four Oaks Works, Sutton Coldfield, near Birmingham.

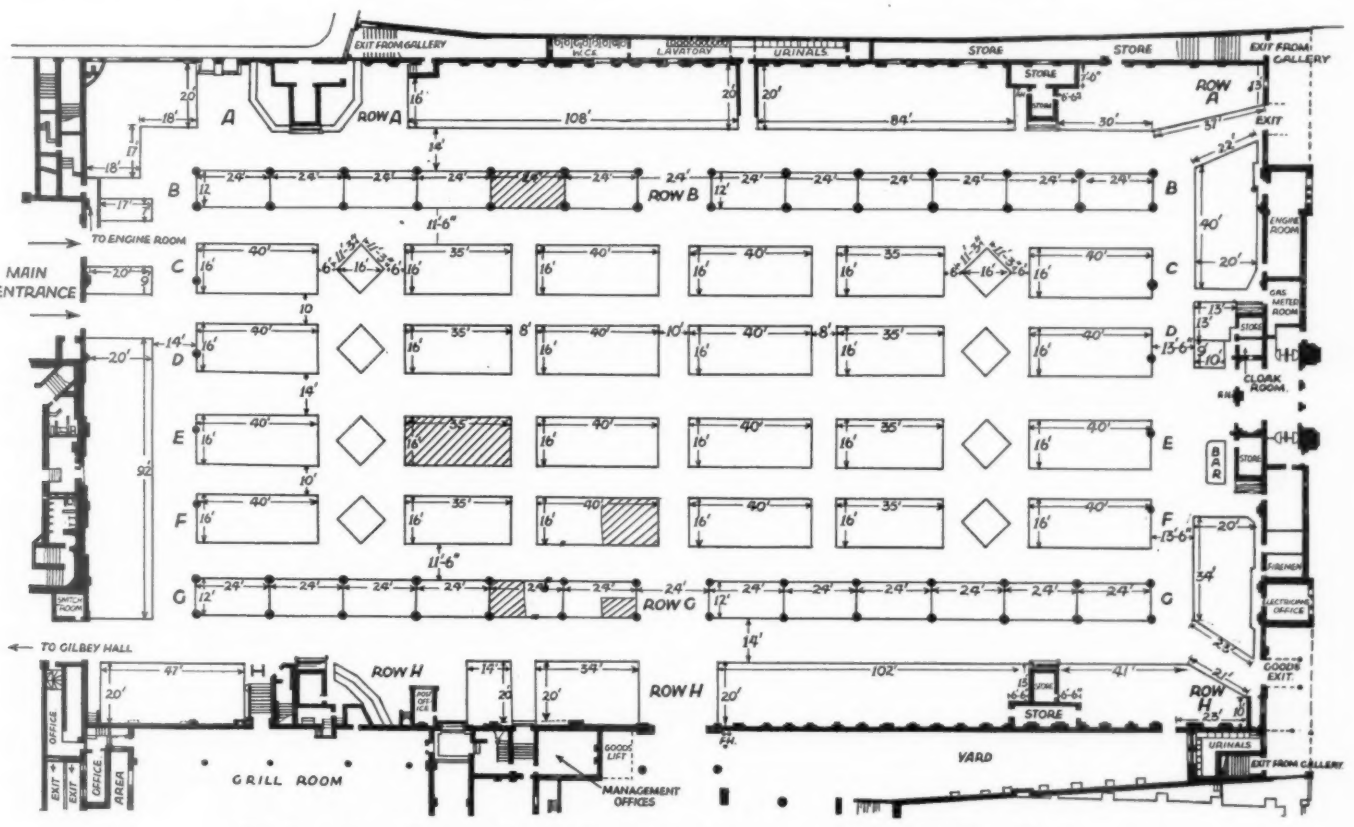
Ridsdale & Company, 3, Wilson Street, Middlesbrough.

J. Parish & Company, 40, Pelham Road, Gravesend.

The United Steel Companies, Limited, 17, Westbourne Road, Sheffield.

Gustav Zimmermann Maschinenfabrik, Theodoostr 290, Düsseldorf-Rath, Germany.

Charles Hearson & Company, Limited, 58, Mark Lane, E.C.3.



The Plan of the Foundry Trades' Exhibition, Agricultural Hall, April 24 to May 3.
(The shaded portions show positions still vacant.)

William Baird & Company, Limited, 168, West George Street, Glasgow, C.2.

Barrow Hematite Steel Company, Limited, Barrow-in-Furness.

Bradley & Foster, Limited, Darlaston Blast Furnaces, Darlaston.

British Foundry Units, Limited, Retort Works, Chesterfield.

British Pig-irons, Limited, Abbey House, 2, Victoria Street, S.W.

The Carborundum Company, Limited, Trafford Park, Manchester.

Colvilles, Limited, 195, West George Street, Glasgow.

The Constructional Engineering Company, Limited, Titan Works, Charles Henry Street, Birmingham.

Wm. Cumming & Company, Limited, Kelvinvale Mills, Maryhill, Glasgow.

The Mond Nickel Company, Limited, Thames House, Millbank, S.W.1.

The Morgan Crucible Company, Limited, Battersea Works, Church Road, S.W.11.

W. T. Nicholson & Clipper Company, Limited, King Street, Salford.

The Penton Publishing Company, Limited, Caxton House, Westminster, S.W.1.

Reavell & Company, Limited, Ranelagh Works, Ipswich.

Robson Refractories, Limited, 47, Coniscliffe Road, Darlington.

H. G. Sommerfield, Limited, Charterhouse Chambers, Charterhouse Square, E.C.1.

Spencer & Halstead, Limited, Northfield Road, Ossett.

Sterling Foundry Specialties, Limited, London, Road, Bedford.

Foundry Equipment, Limited, 15, Victoria Street, S.W.1.

British Moulding Machine Company, Limited, 237, Weston Street, S.E.1.

W. & T. Avery, Limited, Soho Foundry, Birmingham.

F. Gilman (B.S.T.), Limited, 221, High Street, Smethwick.

Leopold Lazarus, Limited, 78/9, Leadenhall Street, E.C.3.

Grant & West, Limited, 17, South Street, E.C.2.

A circular has been sent to holders of the first mortgage debentures of the Darlington Forge, Limited, pointing out that the scheme under which the company will redeem the £323,690 debentures at the price of 20 per cent. has been approved by the debenture holders and sanctioned by the Court. Redemption will be made on April 12.

Silica Sand in Canada.

DEPOSITS AVAILABLE FOR METALLURGICAL REQUIREMENTS.

After iron ore, coal and limestone, silica is one of the most important minerals used in the iron and steel industry. When mixed with the iron ore, it is both a nuisance and an expense; but silica brick, ganister, moulding and core sands and blasting sands are but a few of the many uses to which silica is put in the iron and steel plants and foundries throughout the country. Though there is an abundance of silica throughout Canada of the various grades required, native sources have been developed very slowly in some cases, and a good deal of silica is still imported in both the raw and the manufactured state. It is satisfactory, therefore, to note, states an article in a recent issue of "Iron and Steel of Canada," that more than one Canadian deposit of silica is being developed at present.

During the past three years the Ottawa Silica & Sandstone Company, Limited, has developed a substantial market throughout Eastern Canada, from Halifax, Nova Scotia, to Windsor, Ontario, for its products, which include practically all the kinds of sand required in iron and steel plants in general and foundries in particular. The property of Ottawa Silica & Sandstone Company consists of 76 acres of ground facing on to the Ottawa River at East Templeton, seven miles east of Ottawa. The North Shore line of the Canadian Pacific Railway crosses the property and a short branch line reaches the mill. The convenience of this location can be realised better when it is noted that one can reach the quarry or the mill by car in less than 20 min. from the centre of Ottawa.

The larger part of this 76 acres has little or no soil covering the rock, most of which is sandstone. Beneath the sandstone in several places there is hard, pure quartzite, which is suitable for making ganister and silica brick and may be used for this purpose in the near future. Several quarries have been opened on the property to provide sandstone of various grades, and the one at present being used supplies material that is almost pure silica, the minute amounts of iron and alumina in the rock being in the films of material that bind together the grains of sand and so are removable by washing. The rock after blasting is loaded by hand into 1-ton cars and hauled on narrow-gauge tracks by a small locomotive to the mill, a few hundred yards distant.

Plant Employed.

The 300-ton mill is of up-to-date design and construction, adapted from the model used in silica-sand districts in the United States where a simple and effective technique has been developed. Its features are indicated in Fig. 1. The water supply is drawn from a small lake beside the mill, which is a valuable asset. The rock from the mill bin is fed with water into a 24-in. by 18-in. jaw crusher, which discharges to a 9-ft. wet chaser mill. The chaser breaks down the bond in the soft sandstone, thus releasing the original grains of sand. The rubbing action in this mill also tends to remove from the grains of sand the films of iron oxide and alumina that compose the cementing material of the sandstone. The screens on the sides of the chaser remove only that portion of the rock which is sufficiently disintegrated. Eight log washers, in two banks of four, drag the particles of sand upwards and out of the excess water by means of their revolving spirals, and this excess water, running to waste, carries away with it the particles of iron oxide and alumina. The wet sand from the log washers is practically pure silica, both the iron and the alumina in it being near the vanishing point (0.031 per cent. Fe_2O_3 and 0.10 per cent. Al_2O_3). It is placed by a belt conveyor in drainage piles, where it remains for 48 hrs. when most of the water has drained away.

From the drainage piles the damp sand is dropped on a belt-conveyor system which delivers it to the top of a steam drier, from the bottom of which it is discharged by gravity to a conveyor belt and elevated to the Hum-mer electric-vibrating screens, four in number, which separate it into the various sizes required by the trade. From the screens the sand runs by gravity into bins and thence into railway cars for dispatch. Power was formerly drawn from the hydro-electric system that serves the district; but the cost, for some unaccountable reason, was far too high (3¾ cents per kw.-hr. on the average), so that a 90-h.p. Diesel-electric generating unit was installed last year. As the mill is running at present at about half its rated capacity of 300 tons a day, it is possible to operate it from this 75-kw. generator by running the principal mill units alternately. A second Diesel-electric set is to be installed soon to provide for the increasing daily tonnage. At present the cost of this oil-generated power is less than 1 cent per kw.-hr., including charges for interest, maintenance and depreciation. In addition, the heated cooling water is being used to feed the boilers that furnish steam for the drier, and the hot exhaust gases are to be used soon to supplement the steam supply in the drier, which will effect a further economy and still further reduce the cost of the Diesel-electric power.

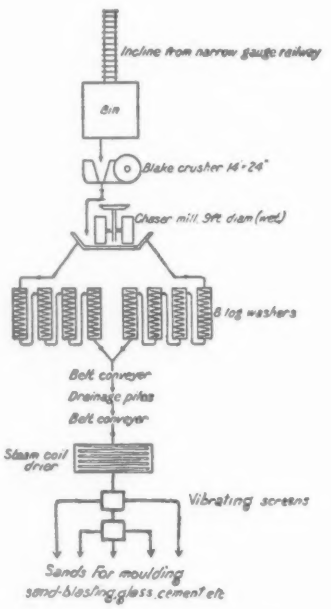


Fig. 1.—Flow Sheet of Mill.

Grading Arrangements.

The screens are arranged at present to give four primary products as follow:—No. 1, 50 to 125 mesh; No. 2 sand blast, 30 to 65 mesh; No. 4 sand blast, 14 to 35 mesh; No. 5, 8 to 14 mesh. From these four screened products additional grades are made by mixing them in the requisite proportions, thus:—No. 2 core—No. 1 and No. 2 sand-blast mixed. No. 3 steel-moulding—No. 4 and No. 2 sand-blast mixed.

From the screens at the chaser are obtained two more coarse grades: No. 6 stucco, about ½ in.; No. 7 stucco and road surface, ⅜ to ½ in. These eight grades of silica sand have already found a market in a wide variety of industries. The most important market for Ottawa silica sand up to the present, however, has been in the steel plants and foundries of eastern Canada. The purity and absolute uniformity of the various grades make it ideal for use as synthetic core sand and moulding sand, which has already replaced naturally-bonded sand in some important Canadian foundries and is rapidly growing in favour on account of the strict control of its quality that can be exerted. A number of iron and steel foundries have found that it requires less oil than other core sands and gives better cores, and some have adopted the practice of adding the spent-core sand to the moulding sand, where its useful life is considerably prolonged. The highly-refractory quality due to its purity makes it a desirable ingredient of synthetic moulding sand for iron foundries and especially so for steel foundries. The addition of this uniformly-sized silica sand to ordinary moulding sand in iron foundries has also been found advantageous, as it opens up the sand and allows the gases to escape more freely.

Another important use for which Ottawa sand has been found very satisfactory is in repairing the linings of cupolas and other furnaces. Mixed with an equal amount of good fireclay, it has proved a valuable material for patching, its refractory nature again being of value, while the fact that the grains of sand are compact and of uniform size helps to prevent too much of a fluxing action with the clay. For sandblasting, this Ottawa sand has been shown to be distinctly superior to the imported varieties, due to the grains being sub-angular in shape rather than rounded, thereby giving a better cutting action and avoiding the rippled surface that results on steel when sand composed of rounded grains is used. Comparative tests made recently by the Dominion Department of Mines with Ottawa sandblast sand and imported sand of the best quality show that the Canadian sand will turn out considerably more work in a given time, thus effecting an important saving in operating cost. The official report points out emphatically that the cutting power of the sand used is a most important factor in the total cost of the sand-blasting operation and that this Canadian sand excels in cutting power, as well as lasting longer than the imported sand.

New Method of Adding Lime to the Basic Converter.—In the "Revue de Métallurgie," F. Bicheroux describes experimental work and practical tests with a new method of adding lime to the converter in the basic process. In the usual process, all the lime is added to the converter with the molten pig-iron, so that during the first few minutes of the blast, the whole of the heat evolved by the oxidation of the Si and Mn is required to heat the lime to the required temperature. The charge itself does not become heated, and the silica formed mixes with the Mn and Fe oxides and causes a violent reaction to follow when the C undergoes combustion, necessitating a reduced blast. To remedy these drawbacks, Bicheroux proposes to add the lime in such a way that during the oxidation of Si the temperature of the charge is able to rise and a fluid slag is formed, and then to continue adding lime during the decarburisation of the slag formed, in sufficient quantity to combine with the free phosphoric acid. The first addition of lime which is pulverised is made before starting the blast, and the second part is mixed with the air and blown through the charge by the blast. The exact quantities of lime required have been determined experimentally and tested over a period of two years in various converters. The blast ports were not choked by the fine particles of lime and no difficulties were experienced as a result of the absorption of moisture by the lime. The details of this practice and its relative advantages and disadvantages are discussed by K. Thomas in "Stahl und Eisen."

The Heat Reactions Involved in the Treatment of Cast Iron with Soda Ash.

By J. E. Fletcher, M.I.Mech.E.

During the discussion of Mr. N. L. Evans' Paper on the use of soda ash in foundry practice, read before a joint meeting of the British Cast Iron Research Association and the London Section of the Institute of British Foundrymen recently, several speakers referred to the doubt which existed in many minds whether the reactions taking place were endo-thermic or exothermic in character. This question is clearly of great practical importance to the foundryman, who naturally wants to know whether molten cast iron, when treated with soda ash, is cooled by its addition.

Early Experiments.

The writer's first experience with soda ash as a desulphuriser was during the war, when casting mixtures of hematite and wrought-iron scrap into pigs for puddling—from the cupola. Ordinary Brunner-Mond soda ash as employed for water softening was used with success, the sulphur content in the cupola mixture being reduced by from 40 to 50 per cent. About the same time hollow-roller castings were being made in metal moulds, the walls of the barrels being $\frac{1}{2}$ in. thick. Owing to the difficulty of obtaining pig-iron sufficiently low in sulphur content the addition of soda ash to the ladle metal was tried and, though the untreated metal sometimes gave short-run defects, the treated metal was fluid enough and gave good results.

The chill was deeper and the riser heads showed a higher sulphur content than that found in the roller barrels—an evidence of the escape to the risers of the low-density sulphide—slaggy beads rich in sulphur oozing through the metal in the riser heads. The presence of silicate of soda in the slag beads was thought to be due to absorption of silica from the ladle linings and some difficulty was experienced when frozen particles of the glassy alkali slag were trapped in the surfaces of the castings—the skimming of the slag from the surface of the metal in the ladles being difficult in the days when crushed limestone as a slag thickener was unknown.

More recent experience has shown that, provided the metal is tapped at a sufficiently high temperature, cast iron treated with soda ash does not suffer from lack of fluidity and has been successful in yielding sound light castings of $\frac{1}{8}$ in. thickness. It has been observed that the efficiency of the desulphurising and cleansing actions of the soda ash is associated with high temperatures in the metal as poured into the ladle, and that when this is the case the desulphurising action is accompanied by a loss of silicon in the treated cast iron.

In an article* on the function of slags in the cupola the writer referred to the significance of the fact that the soda-ash desulphurising process depends upon the production of a highly superheated fluid slag, during the formation of which the heat reactions are exothermic and in further investigation of this phase of the problem, the following notes on the mechanism of the reaction will, it is hoped, throw further light on the subject.

The Reactions.

In the case where soda ash is used in the ladle the following reactions take place:—

The first involves the Na_2O and CO_2 in the soda ash, the carbonate being decomposed, CO_2 being liberated. $Na_2CO_3 \longrightarrow Na_2O + CO_2$. After this dissociation the Na_2O is ready for the main reactions. The second or desulphurising reaction is between the Na_2O and the manganese and iron sulphides in the metal, resulting in the formation of Na_2S, MnO and/or FeO in accordance with the following expression:—

$$Na_2O + MnS \longrightarrow Na_2S + MnO$$

or

$$Na_2O + FeS \longrightarrow Na_2S + FeO$$

Na_2S.MnO and/or FeO enter the slag.

This reaction demands only a portion of the soda ash used.

The third reaction is concerned with the formation of sodium silicate Na_2SiO_3, silicon from the cast iron being oxidised, uniting with Na_2O from further decomposed soda ash in accordance with the expression given below:—

$$Si + O_2 + Na_2O \longrightarrow Na_2O.SiO_2$$

The final reactions are associated with the formation of the sodium flame, accompanied by the oxidation of sulphur in the primarily formed Na_2S.

The mechanism of the flame reaction is not completely understood, for, as the odour of acetylene is distinctly present during the formation of the flame, hydrogen and carbon from the metal may react with the sodium in the remaining soda ash. In the absence of more definite knowledge of the flame reaction, the writer has estimated the balance or remainder of the sodium in the soda ash to be oxidised to Na_2O in forming the flame.

Example.

In an actual case 1 lb. of soda ash was added in the ladle per 100 lbs. of molten cast iron of the following analysis:—Total carbon, 3.20; silicon, 2.00; manganese, 0.49; sulphur, 0.08; and phosphorus, 1.02 per cent. In the treatment the metal lost 0.15 per cent. silicon and 0.04 per cent. sulphur.

Dissociation of Na_2CO_3.—1 lb. soda ash contains 0.434 lb. Na_2 + 0.151 lb. O_2 + 0.415 lb. CO_2 (0.585 lb. Na_2O).

The dissociation of Na_2CO_3 is in accordance with the expression:—

$$Na_2CO_3 \longrightarrow Na_2O + CO_2$$

and is accompanied by a heat loss of

2,190 B.T.U. per lb. of Na_2O
or 2,950 „ „ Na.

The dissociation of 1 lb. of soda ash containing 0.434 lb. Na or 0.585 lb. Na_2O liberates 0.415 lb. CO_2 and requires

$$\left.\begin{matrix} 0.434 \times 2{,}950 \\ \text{or} \\ 0.585 \times 2{,}190 \end{matrix}\right\} = 1{,}280 \text{ B.T.U.}$$

This involves a loss of heat in the molten iron, the estimated fall in metal temperature being approximately 43 deg. F. or 24 deg. C.

100 kg. iron loses 16.75 calories per 1 deg. C. fall in temperature,
or 100 lbs. „ „ $16.75 \times 1.8 = 30$ B.T.U. per 1 deg. F. fall in temperature.

Metal temperature fall = 1,280/30 = 42.7 deg. F. (23.8 deg. C.).

Desulphurising Reaction.

In this reaction 0.04 lb. sulphur is lost per 100 lbs. of metal treated, the reaction being as shown below:—

$$\underbrace{Na_2O + O}_{Na_2} + \underbrace{MnS}_{Mn+S} \longrightarrow \underbrace{Na_2S}_{Na_2+S} + \underbrace{MnO}_{Mn+O}$$

46	16	55	32		46	32	55	16
.0575	.02	.0675	.04		.0575	.04	.0675	.02

0.0775 Na_2O containing 0.0575 lb. Na is dissociated
0.1075 MnS „ 0.0675 lb. Mn „
0.0975 Na_2S „ 0.0575 lb. Na is formed
0.0875 MnO „ 0.0675lb. Mn „

The heat loss in the dissociation of the Na_2O is $0.0575 \times 3{,}940 = 226$ B.T.U.
The heat loss in the dissociation of the MnS is $0.0675 \times 1{,}490 = 101$ B.T.U.
The heat evolved in the formation of Na_2S is $0.0575 \times 3{,}500 = 201$ B.T.U.
The heat evolved in the formation of MnO is $0.0675 \times 2{,}980 = 201$ B.T.U.

From the above it will be seen that the reaction is slightly exothermic:—

$$\underset{\text{gain}}{(201 + 201)} - \underset{\text{loss}}{(226 + 101)} = 75 \text{ B.T.U.}$$

The weight of soda ash involved in the desulphurising reaction is 0.1325 lb., or 13.25 per cent. of the total soda ash used.

Desiliconising Reaction.

Analysis of the treated cast iron shows that further silicon was oxidised during the soda-ash process, and in this typical case the metal in the unmelted mixture contained 2.2 per cent. silicon, and after melting 2.0 per cent. After treatment with the soda ash the silicon content was 1.85 per cent.

In the first portion of this action SiO_2 is formed, which later unites with Na_2O to form the silicate Na_2SiO_3.

The first reaction is:—

Si	+	O_2	=	SiO_2
28		32		60
0.15		0.172		0.322

The heat evolved in this reaction is as shown below:—

$$0.15 \times 12{,}600 = 1{,}890 \text{ B.T.U.}$$

The second reaction is:—

SiO_2	+	Na_2O	=	Na_2SiO_3
60		62		122
0.322		0.333		0.655

The heat evolved in this reaction is as given below:—

$$0.655 \times 675 = 455 \text{ B.T.U.}$$

The reactions are exothermic:

$$1{,}890 + 455 = 2{,}345 \text{ B.T.U.}$$

The weight of soda ash employed in the above reaction is 0.565 lb., or 56.5 per cent. of the total soda ash used.

Flame Reactions.

The remainder of the Na_2O after the completion of the desulphurising and desiliconising reactions is 0.1745 lb., containing 0.129 lb. Na. The heat involved in the flame reaction is uncertain, but if it be assumed that the oxygen of the remaining Na_2O is taken up by sulphur in forming SO_3, 0.129 lb. Na, when oxidised to Na_2O, will evolve

$$0.129 \times 3{,}940 = 508 \text{ B.T.U.}$$

Finally, if the sulphur in the Na_2S resulting from the desulphurising reaction is oxidised to SO_3 during the flame period there will be practically no evolution of heat, as the heat required to dissociate the Na_2S is practically the same as that evolved when the sulphur in the Na_2S is burnt to SO_3.

Summarising the above results, it will be seen that the heat evolved in the main reactions is:—

	Proportion of soda ash used.	B.T.U. evolved.
	Per cent.	Per cent.
In the desulphurising reaction	13.25	75
In the desiliconising reaction	56.50	2,345
In the flame reaction	30.25	508
Total heat evolved in exothermic reactions	100.00	2,929

Subtracting from the above 1,280 B.T.U. lost in the dissociation of Na_2CO_3, the net exothermic reaction is 1,648 B.T.U. per 100 lbs. of metal treated.

Thermal Data.

In estimating the above, the data used have been taken from J. W. Richard's "Metallurgical Calculations."

(1) The heat of formation of Na_2CO_3 is 1,219 cal. per kg. Na_2O

* "Fuel Economy Review," Vol. xi, 1932.

2,190 B.T.U. per lb. of Na_2O (combination of $Na_2O + CO_2$).

(2) The heat of formation of Na_2S is 1,941 cal. per kg. Na

3,500 B.T.U. per lb. of Na.

(3) The heat of formation of Na_2O is 2,183 cal. per kg. Na

3,940 B.T.U. per lb. Na.

(4) The heat of formation of Na_2SiO_3 (from constituent oxides) is 375 cal. per kg. silicate

675 B.T.U. per lb. silicate.

(5) The heat of formation of MnS is 829 cal. per kg. Mn

1,490 B.T.U. per lb. Mn.

(6) The heat of formation of MnO is 1,653 cal. per kg. Mn

2,980 B.T.U. per lb. Mn.

(7) The heat of formation of SiO_2 is 7,000 cal. per kg. Si

12,600 B.T.U. per lb. Si.

(8) The heat of formation of SO_3 is 2,872 cal. per kg. S

5,170 B.T.U. per lb. S.

Further Examples.

Three further examples taken from actual practice indicate the relative effectiveness of the process in the treatment of cast irons of different analysis.

	Si.	Mn.	S.
	Per cent.	Per cent.	Per cent.
Cast iron A.			
Soda-ash blocks in cupola	3.0	0.4	0.06 before melting.
	2.7	0.34	0.09 after melting.
	2.5	0.30	0.08 after treatment.
Cast iron B.			
Ladle addition	2.5	0.60	0.07 before melting.
	2.25	0.50	0.10 after melting.
	2.10	0.46	0.07 after treatment.
Cast iron C.			
Ladle addition	2.0	0.80	0.08 before melting.
	1.8	0.68	0.11 after melting.
	1.7	0.62	0.07 after treatment.

1 lb. soda ash used per 100 lbs. cast iron.

Desulphurising action.	*Soda ash used.*	*Sodium content.*
	Per cent.	Lb.
Cast iron A.—0.01 S removed	0.029	0.013
„ B.—0.03 S „	0.087	0.038
„ C.—0.04 S „	0.116	0.051
Desiliconising action.		
Cast iron A.—0.20 Si removed	0.754	0.328
„ B.—0.15 Si „	0.565	0.246
„ C.—0.10 Si „	0.377	0.164
Sodium flame action.		
Cast iron A.—0.094 Na in flame	0.217	0.094
„ B.—0.154 Na „	0.348	0.154
„ C.—0.220 Na „	0.507	0.220

The soda ash and sodium employed in the three types of reaction are shown, and it will be noted that the removal of silicon beyond that normally lost in cupola melting directly influences the exothermic character of the net reactions. The heat evolved in the various reactions is shown in Table I.

The dominating influence of the silicate-forming reactions is clearly seen; without it the action on the molten cast iron would result in only a trifling rise or a fall in the metal temperature.

When it is remembered that 100 lbs. cast iron at, say, 1,400 deg. C. contains approximately 530,000 B.T.U., one-fifth of which is latent heat, the influence of an additional 1,200 to 1,800 B.T.U. is not inconsiderable and may be expected to increase the fluidity of the metal when raising its temperature some 40 to 60 deg. F.

To raise 1 kg. iron 1 deg. C. (from 1,400 deg. C.) requires 0.1675 cal.

To raise 1 lb. iron 1 deg. F. (from 2,552 deg. F.) requires 0.30 B.T.U.

To raise 100 lbs. iron 1 deg. F. (from 2,552 deg. F.) requires 30 B.T.U.

Table I.—*Heat Evolved in Three Typical Cases.*

	Cast iron A. B.T.U.	*Cast iron B.* B.T.U.	*Cast iron C.* B.T.U.
Heat evolved :—			
In desulphurising reaction ..	19	56	75
In desiliconising reaction ..	3,130	2,348	1,565
In flame reaction	370	606	867
Total	3,519	3,010	2,507
Less heat absorbed in CO_2 expulsion	nil	1,280	1,280
Net heat generated	3,519	1,730	1,227
Estimated rise in metal temperature	117 deg. F. (65 deg. C.)	58 deg. F. (32 deg. C.)	41 deg. F. (23 deg. C.)

A further correction is necessary in order to allow for the heating of 0.565 lb. of CO_2 liberated from 1 lb. soda ash during its passage through the molten metal.

If the CO_2 becomes heated to the temperature of the metal (2,552 deg. F. or 1,400 deg. C.) the metal must lose about 440 B.T.U. (0.565 × 0.31* × 2,500 = 437.5 B.T.U.) when soda ash as charged is at 52 deg. F. This action would reduce the metal temperatures as given by, say, 15 deg. F. or 8 deg. C. Taking the foregoing estimates to be fundamentally correct, it is not difficult to forecast the result of adding different additions of soda ash to cast iron in the ladle.

(1) *Effect of Dissociation of Na_2CO_3.*

As 1 lb. of soda ash contains 0.585 lb. Na_2O and 0.415 lb. CO_2, the B.T.U. required for the dissociation of the Na_2CO_3 is 2,190 per lb. of Na_2O.

0.585 × 2,190 = 1,280 B.T.U. per lb. of soda ash used per 100 lbs. cast iron.

1 lb. soda ash per 100 lbs. cast iron cools the metal by 43.7 deg. F.

(2) *Effect of Desulphurising Reaction.*

As 0.04 lb. of sulphur is removed by 0.0775 lb. Na_2O or 0.1325 lb. soda ash, each 0.01 lb. S removed from 100 lbs. cast iron requires 0.0331 lb. soda ash or 0.0194 lb. Na_2O. This contains 0.0144 lb. Na. The heat evolved in the elimination of 0.01 lb. S from 100 lbs. cast iron is 18.75 B.T.U.

The B.T.U. generated per lb. of soda ash used in this reaction is 18.75/0.0331 = 567 B.T.U.

Heat generated during the removal of—

0.01	per cent. S is	18.75	B.T.U.
0.02	„ „	37.50	„
0.03	„ „	56.25	„
0.04	„ „	75.00	„
0.05	„ „	93.75	„
0.06	„ „	112.50	„

* Specific heat of CO_2 at 2,552 deg. F is 0.31.

(3) *Effect of Desiliconising Reaction.*

As 0.15 lb. of Si requires 0.565 lb. soda ash, forming 0.655 lb. Na_2SiO_3, and evolves 2,345 B.T.U., it follows that each 0.1 per cent. Si removed from the 100 lbs. of molten cast iron requires 0.377 lb. soda ash and evolves 1,565 B.T.U.

Heat generated during the removal of—

0.10	per cent. Si is	1,565	B.T.U.
0.15	„ „	2,347	„
0.20	„ „	3,130	„
0.25	„ „	3,612	„
0.30	„ „	4,695	„

In the investigation of a number of cast irons of analysis varying between 3.5 and 1.5 per cent. silicon it has been noticed that when the silicon content of the iron treated with soda ash is about 3.5 per cent. the percentage of silicon removed by the treatment is higher than in the case of a 1.5 per cent. silicon iron, whilst the sulphur removed from the high silicon iron is lower than that from the low silicon iron. This might be expected from the fact that high-silicon irons are generally lower in sulphur content than low-silicon irons.

Much depends upon the temperature of the metal whilst the reactions are taking place, upon the efficiency of the cupola melting, and upon the character of the cupola metal charges. When cast irons of silicon content above, say, 4.5 per cent. (silky fracture) and ferro-silicons of between 8 and 15 per cent. silicon are treated, the percentage of silicon removed by the soda ash is often relatively less than in the case of normal cast irons and the percentage of sulphur removed may be abnormally low.

Table II.—*Heat Evolution related to S and Si Removal.*

Removal of		Soda ash required for removal of		Total $a + b$	Soda ash for flame action.	Total soda ash.
S.	Si.	S. a	Si. b			
Per cent.	Per cent.	Lb.	Lb.	Lb.	Lb.	Lb.
0.01	0.30	0.0331	1.131	1.164	nil	1.164
0.02	0.25	0.0662	0.943	1.009	nil	1.009
0.03	0.20	0.0993	0.754	0.853	0.147	1.000
0.04	0.15	0.1324	0.565	0.697	0.303	1.000
0.05	0.10	0.1655	0.377	0.542	0.458	1.000

In Table II the order of sulphur and silicon removals during the soda-ash reactions from cast irons varying in analysis between 3.0 per cent. Si : 0.06 per cent. S and 2.0 per cent. Si : 0.08 per cent. S are shown in relation to the weight of soda ash required in the corresponding desulphurising, desiliconising and flame reactions.

The estimated heat units generated in the above five cases are shown in Table III.

The estimated increase in the metal temperature as a result of the reactions is shown in brackets below the B.T.U. values (given in degrees F.).

Table III.—*Removal of S and Si.*

	S. 0.01 Si. 0.30	S. 0.02 Si. 0.25	S. 0.03 Si. 0.20	S. 0.04 Si. 0.15	S. 0.05 Si. 0.10
B.T.U. generated cupola method	4,714 (142)	3,650 (107)	3,436 (99)	2,930 (83)	2,428 (76)
B.T.U. generated ladle method	3,434 (99)	2,370 (64)	2,156 (57)	1,650 (40)	1,148 (23)

Per 100 lbs. molten cast iron treated.

The Use of Soda-Ash Blocks in the Cupola Charges.

When soda-ash blocks are added to the cupola charges, the CO_2 of the Na_2CO_3 is driven off by the time the charges have reached a level where the temperature is in excess of about 850 deg. C. This level is some feet above the top of the coke bed, and when the charges containing free soda (Na_2O) reach the horizon of slag formation (below the metal-melting level) the temperature of the soda will be high enough to unite with any adjacent silica to form a small proportion of the sodium silicate eventually found in the cupola slag.

It is in the region of the zone of high superheat, just above the main tuyeres, that the heated soda

(*Concluded on page* 248.)

Aluminium Metallurgy.*

By N. F. Budgen, M.Sc., Ph.D.

Introduction.

With the exception of silicon, aluminium is the most abundant metal in the world. Its natural compounds have been known for centuries, and, in fact, the use of certain of these for dyeing purposes was described by Pliny nearly 2,000 years ago. Yet it was not until a little more than 100 years ago that the metal was isolated for the first time, and more than 60 years elapsed after this first discovery before the metal was made in sufficient quantities and at a sufficiently low price to enable it to take its place among the ordinary metals of commerce.

The modern development of the aluminium industry owes its origin to the simultaneous discovery in 1886 by Hall in America and Héroult in France of a molten solution capable of yielding aluminium under electrolysis. The metal occurs abundantly in the form of its oxide, alumina, but the direct electrolysis of molten alumina is out of the question owing to the fact that its melting point is over 2,000 deg. C. The Hall-Héroult invention consisted of the discovery that a molten fluoride, such as cryolite, will dissolve substantial quantities of alumina at the comparatively low temperature of 800 to 900 deg. C., and that the molten solution is capable of being electrolysed. This discovery revolutionised the industry. Whereas previously aluminium had been produced by a costly and laborious chemical process, involving the reduction of aluminium salts by metallic sodium, the new method enabled the production of aluminium in considerable quantities and at one-twentieth the cost. Almost at once the new industry began to grow rapidly. By the beginning of the present century the world consumption had increased to 6,000 tons per year, and since then progress has continued until to-day the world is consuming aluminium at the rate of over a quarter of a million tons per annum.

Production of Aluminium.

The production of metallic aluminium from the raw material, as carried out to-day, is divided into two distinct stages—first, the preparation of pure alumina from the mineral ore, which is done by a wet chemical process; and subsequently the electrolytic reduction of the oxide.

Ore.

Aluminium is an important constituent of practically all common rocks, clay and various soils, in which it occurs as a silicate or as an oxide. The material normally used for aluminium production is a mineral known as bauxite, which exists in many varieties. It is, essentially, a mixture of oxides, principally those of aluminium, silicon and iron, the proportions of which vary according to the locality. Large deposits occur in the North of Ireland, the South of France, British Guiana, and in many other places throughout the world, though all varieties are not equally suitable for aluminium production.

Preparation of Alumina.

The process of extraction of pure alumina from bauxite, commences with the crushing, calcining and grinding of the ore, which is then digested with caustic soda in autoclaves under a pressure of 60 to 70 lbs. per sq. in. The alumina goes into solution as sodium aluminate in accordance with the equation:—

$$Al_2O_3 + 2NaOH = Na_2Al_2O_4 + H_2O$$

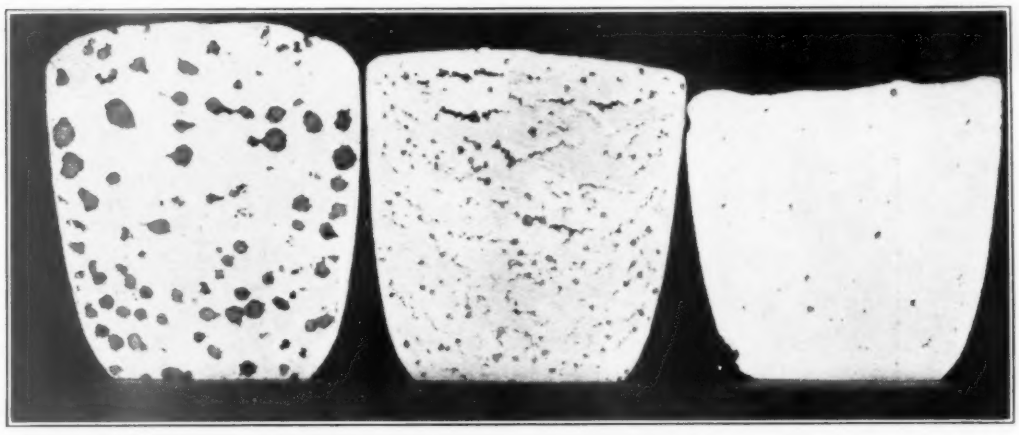


Fig. 1.—Shows 2L5 Alloy Solidified under Differing Conditions.

The iron oxide and the lesser impurities present in the bauxite are insoluble, and the silica present reacts with the solution forming an insoluble sodium aluminium silicate. The clear solution of sodium aluminate is filtered off, and the residue, known as red mud, containing the iron oxide and other impurities of the bauxite, is a by-product which has some value in industry as a pigment.

The sodium aluminate solution is unstable, and on allowing to cool, it slowly decomposes, with the precipitation of aluminium hydroxide. This precipitation is accelerated by the addition of a little aluminium hydroxide, and by the agitation of the solution by stirring. The hydrated alumina is separated by filtration, and is calcined to drive off the water of combination, leaving the alumina as a fine white anhydrous powder ready for the electric furnaces.

Generation of Electricity.

Now for the economic production of aluminium vast quantities of cheap electricity are required, the only satisfactory means of generation being harnessing of the power of falling water. The problem of obtaining power in bulk at a low rate is one of prime importance, and, in so far as Great Britain is concerned, the chief source lies in the water powers of Scotland, where the British Aluminium Company, Limited, have developed their reduction works at Foyers, Kinlochleven, and recently at Lochaber. The Lochaber works constitutes one of the most interesting instances of civil engineering construction of modern times. An important feature is a water tunnel, 15 ft. in dia., which has been driven through the Ben Nevis range for a total distance of 15 miles. This tunnel is designed to carry 860 million gallons of water per day, an amount sufficient to fulfil the domestic daily requirements of half the population of the British Isles.

Electrolysis.

The furnace employed for the electrolytic reduction of alumina is simple in construction. It consists of a large rectangular open bath, lined on sides and bottom with carbon, this carbon constituting the cathode of the cell. The anodes consist of a number of carbon blocks which dip into the open top, and the method of fixing is so arranged that their height may be adjusted from time to time as the carbon is consumed. The bath is packed with a mixture of alumina and cryolite, the latter being a natural double fluoride of aluminium and sodium, which is found in great abundance in Greenland, but is now also produced synthetically. The mixture is readily fused and kept molten by the heat of the current passing between the anode and cathode, which at the same time dissociates the alumina into oxygen and aluminium. The metal is deposited in a molten condition on the floor of the furnace, from which it is tapped off at intervals and cast into ingots. The liberated oxygen combines with the carbon anode to form carbon monoxide, finally burning to carbon dioxide. The cryolite itself is unattacked at the voltage applied, and serves merely as a flux or solvent for the alumina.

The process of reduction is a continuous one; fresh alumina is added as the bath becomes impoverished, and the carbon electrodes are lowered as they are consumed, being replaced, when necessary, without interrupting the operation. The furnaces operate for considerable periods without ceasing, until, due to continuous action of the heat, and the gradual absorption of aluminium and impurities, the carbon lining cracks or erodes, and relining becomes necessary.

The purity of the metal produced depends essentially upon the purity of the materials employed. Aluminium may be refined electrolytically after production, but the process is by no means simple, and cannot yet be looked upon as suitable for mass production. For all practical purposes, however, this is unnecessary, and by eliminating impurities, firstly in the alumina, and secondly in the carbon employed for the anodes and furnace linings, it is possible to ensure a good quality of metal.

The manufacture of carbon electrodes is in itself an important auxiliary business which contributes a heavy item to the cost of aluminium production. In preparing the electrodes, petroleum coke is employed, this being a residue obtained in the distillation of heavy crude oil. The coke is ground, mixed with a binder of pitch or tar and compressed into blocks. These are fired at about 1,000 deg. C. to render the finished product. The anodes so prepared yield an extremely low ash content, practically free from impurities.

Aluminium Casting Alloys.

Aluminium castings are, practically without exception, aluminium alloy castings, the alloying elements being added to improve both the mechanical properties and the casting characteristics of the metal. While a great diversity of alloys has been investigated and many of them patented, there is a relatively small number in general commercial use.

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* A Paper read before the Scottish Branch of the Institute of British Foundrymen at Glasgow.

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In aluminium casting alloys, the increase in tensile strength, yield point and hardness, due to the alloying elements, is generally accompanied by a decrease in elongation, and by some sacrifice of corrosion resistance. The extent to which the various properties are affected depends upon the alloying element, and upon the amount which is added. In general, the strength increases with increasing percentage of added element up to a certain point, beyond which the only effect is to produce excessive brittleness. This limiting percentage varies widely with different alloying elements. The alloying constituents of aluminium are practically confined to copper, zinc, manganese, Si, magnesium, nickel and iron. The alloys 2L5, 3L11, Y, 2L8 and DTD25 or silumin and alpax are more generally used than any others. The reason that these alloys have been selected is undoubtedly due to the fact that they have been subjected to so much close scientific investigation, notably at the N.P.L. and by various research institutions in Europe and America.

Casting Processes.

The three types of casting process in commercial use at the present time are (1) sand casting; (2) permanent-mould or die casting, in which the metal is poured into a mould made of cast iron, and (3) pressure die casting, in which the alloy is forced under high pressure into a steel mould. In the permanent-mould method the cores are made of steel, while in the variation of this process, known as the semi-permanent-mould method, the cores are made of sand.

Each of these processes has its rather definite field of application and advantages. The latter two processes are applicable only where a large number of identical parts are required, because the cost of the dies is high. Where only a small number of castings are to be made, or where the casting is very large, the sand process is obligatory. The maximum weight of an aluminium-alloy gravity die-casting or pressure die-casting seldom exceeds 20 lbs., and weights under 10 lbs. are most common.

The use of metal moulds permits working to closer tolerances and produces a better surface. Finishing costs, machining and polishing are thus reduced to a minimum. For sand castings tolerances are expressed in eighths and sixteenths of an inch, for permanent-mould castings in thirty-seconds and sixty-fourths, and for die castings in thousandths of an inch. The pressure die-casting process is especially suited for castings having thin sections such as meter cases, typewriter frames, carburetters, gramophone and vacuum-cleaner parts and the like. One of the largest uses of the permanent-mould process is in the manufacture of pistons and similar parts for motor engines.

In the sand-casting process almost all the standardised alloys can be used. For the permanent-mould process generally all the alloys are used except 2L5, which, on account of its 13 per cent. of zinc, is too hot short, and gives cracked castings before they can be removed from the mould. For the pressure-casting process unmodified aluminium-silicon alloys with about 8 per cent. of silicon are most generally employed.

"Y" alloy or 2L8 are generally used for castings to withstand stresses at high temperatures, because they are stronger under these conditions. Silicon alloy is remarkable for its freedom from hot shortness, its fluidity in the mould, corrosion resistance and malleability.

Melting Practice.

The melting of aluminium and its alloys can be accomplished in a variety of furnaces. The types of furnace most generally employed include crucible, reverberatory and iron-pot, each of which may be fired either by coke, coal, oil or town's gas. Electric melting, the ideal method, has not progressed far yet. For many years a great amount of aluminium was melted by the industry in cast-iron pots. The cast-iron pots are relatively cheap, conduct the heat rapidly and, provided they are suitably protected from the aluminium by whitewashing inside, there is very little dissolution of iron in the aluminium. It is important to have the iron pots of close-grained cast iron, low in phosphorus, otherwise there is the possibility of the phosphide eutectic, which melts at about 900 deg. C., leading to rapid failure. Properly-made pots will last several weeks' continuous use before they run out.

Crucibles are clean and satisfactory for melting while they are new, but after they have been in service some time, especially when oil fired, a good deal of the graphite is burned out of the walls.

Open flame furnaces are of simple type, consisting of a steel cylinder lined with firebrick and having burners blowing their flame into the working chamber. Such furnaces are often employed for the melting of aluminium-silicon alloys, since these alloys cannot be satisfactorily melted in iron pots on account of dissolution of the iron. Reverberatory furnaces for such an alloy may advantageously be lined with magnesite bricks, which are not affected by the aluminium-silicon alloys.

Fluxes.

Generally speaking, there is not much occasion to apply fluxes to aluminium during melting. The ordinary alloys may, with advantage, be fluxed with about ½ per cent. of zinc chloride just before skimming. The zinc chloride causes violent ebullition of the molten metal and appears to release entrained dross and oxide.

Gases in Aluminium Alloy Castings.

Pinholes, or "speckled metal," are the small, variously-shaped cavities, which look like black specks and are sometimes seen in sand castings; they may vary in size from $\frac{1}{64}$ in. to $\frac{1}{16}$ in. or more in diameter. They are due to evolution of gas on solidification of the alloy. The principal objections to them are that they signify unsoundness with concomitant weakness, and often lead to porosity of castings which may be required in service to withstand pressure. They do not generally appear on "as-cast" surfaces except sometimes on the surface of metal cast in open moulds, but are only revealed by either machining or polishing. Pinholes are generally non-apparent in gravity and in pressure die castings, but appear principally in thick sections of sand castings.

It will be noted that pure aluminium shows no pinholes at all. It is a curious fact that pure aluminium rarely does show pinholes even though it may contain 30 to 40 per cent. of its volume of gas. But if some other element is added, pinholes at once make their appearance. The added element is believed to disturb the gas equilibrium and cause rejection on solidification.

It is now fairly well established that pinholes are largely due to evolution, on solidification, of gas which was absorbed while the alloy was molten. There are various factors which operate to cause the contamination of aluminium by gases, and once the gases are taken up, they do not readily come out again in such a manner as to leave the aluminium gas-free without some step being taken to remove them.

An experiment which rather clearly demonstrates the presence of gas in an alloy which did not show any pinholes is that illustrated in Fig. 1, which shows sectioned blocks of 2L5 alloy allowed to solidify in the crucible in which they were melted. The right-hand sample of Fig. 1 was solidified in a moderately complete vacuum, and the left at ordinary air pressure; the middle one was solidified at an intermediate pressure.

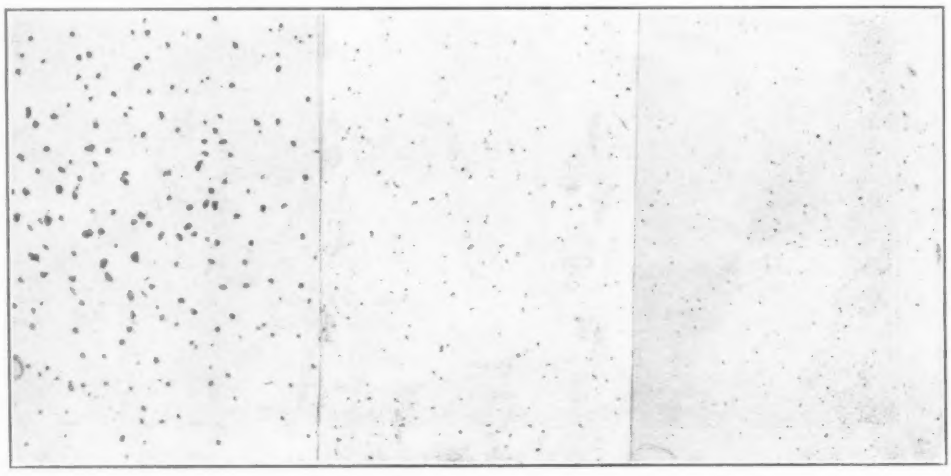

Fig. 2.—Shows the Influence of Fuel on Soundness of Aluminium Alloys. The left one was prepared in a Coal-fired Reverberatory Furnace; the middle one in an Oil-fired Reverberatory Furnace; the right one in a Coke-fired Crucible Furnace.

The gas present in the alloy is expanded by the reduced pressure, and the metal then solidifies.

In excessively gassed samples a certain amount of exudation from runners and risers is observable. This, however, is very occasionally seen, and is only noticeable in samples poured at extremely high temperatures. It is also probably unlikely to occur except in the presence of some such element as iron, present in considerable amount. Present knowledge points to the fact that the principal gas giving rise to pinholes is hydrogen.

The solubility of gases in molten aluminium alloys increases as the temperature is raised, hence more gas is absorbed in a given time at a high than at a lower temperature. The extent of absorption is also a function of the time that the metal or alloy is maintained molten.

Relatively recently the deleterious effects of water vapour in contact with molten aluminium alloys has been observed. It appears that the water vapour is decomposed and hydrogen absorbed. Water vapour should, therefore, be guarded against from such possible sources as the heating fuel, whether it be coal, coke, town's gas or oil, the products of combustion of which are liable to contain water vapour.

Some authorities have even suggested that unusual humidity of the atmosphere as on very

damp days, may, by bringing unusual amounts of water vapour in contact with the molten surface, allow of some H_2O conversion taking place and of hydrogen being absorbed.

Exposure to Corrosive Conditions as a Cause.

Recent research work has shown that pure aluminium as well as alloys, when exposed to corrosive conditions and subsequently sand-cast, are found to be unsound and to contain pin-holes. Exposure indoors under good dry conditions produces no deterioration, but exposure outdoors, followed by melting and casting, gives metal showing large numbers of pin-holes. It is thought that the deterioration is the result of electrolytic action, involving the liberation of hydrogen in the nascent state, which is absorbed by the metal. On remelting and casting the hydrogen is evolved in the molecular condition and produces the pin-holes.

Certain practical considerations arise from these observations. It is clearly necessary that aluminium and its alloys should be stored under better conditions than those general in many foundries, particularly when stocks are held for long periods. There is no doubt that much of the gas in commercial aluminium alloys is introduced by exposure of the solid metal to moisture between the time when it leaves the producer's furnace and the time when it is finally melted in the foundry; *i.e.*, during transport and in store. Gas so introduced remains in the molten metal in sufficient quantities to give defective castings, even under the best melting conditions —as, for example, in electric furnaces.

Generally it is difficult to prevent some additional deterioration especially in furnaces using coal, gas or oil as fuel, owing to the high content of water vapour in the atmosphere from such fuels. Coke-fired furnaces are less likely to damage good metal, whilst electric melting is still better, and, with proper care, sound sand-castings can be obtained from either type of furnace, provided that the metal is initially good. Oil is intermediate and gas is bad, as also is coal.

Fig. 2 shows the effect of three different types of melting furnaces on metal maintained molten for the same period. The conditions here were exaggerated as much as possible for these tests. In view of the remarks just made regarding corrosion deterioration, the use of scrap metal requires careful consideration. Miscellaneous scrap from outside sources, much of which has been either in service or exposed under injurious conditions is usually corroded to a greater or less degree. Such scrap is likely to contain a high-gas content, and should be reserved for work in which trouble from this cause is not likely to be experienced, such as chill castings or very thin sections.

Effect of Melting Temperature.

It is a fact that, while "drawing" can to a large extent be minimised by changes in moulding method, yet the "drawing" tendency increases with the coarseness of the crystal structure in the casting. Whenever a coarse crystal structure is produced in a casting, the tendency for "drawing" is invariably stronger than is the case when the crystal size is fine. Factors causing a coarse structure, and therefore the tendency for "drawing" and cracking are excessive melting or pouring temperatures, and soaking of the metal in the molten condition. Tests made with a simple shallow dish casting in 8 per cent. Cu Al alloy are illuminating in this connection.

In these experiments melting temperatures ranging from 715 to 930 deg. C. were employed. It was found by trial that 715 deg. C. was the lowest pouring temperature at which the metal completely filled the mould, with the arrangement of gates used. During the heating of the melt, metal was removed at the desired temperatures up to 930 deg. C. and poured when it had cooled to the pouring temperature of 715 deg. C.

The important point to bear in mind regarding these tests on the influence of melting temperature is that once the metal has been over-heated it has suffered certain detrimental effects which simply cooling down to the correct temperature does not correct.

Effect of Pouring Temperature.

The results just given indicate that if the metal had been poured at the high temperature to which it had been raised more harm would have resulted than occurred when the metal was cooled to a low temperature, before pouring.

Control of pouring temperature is thus quite as important as control of melting temperature. The effect of a high pouring temperature is markedly more harmful than that of a high melting temperature alone.

Effect of Soaking.

The effect which maintaining metal molten has upon the grain size is dependent upon the temperature and the time molten. The 8 per cent. CuAl alloy maintained molten at 715 deg. C. for up to 24 hrs. does not seem to coarsen appreciably. But when the temperature is 790 deg. C., there is very considerable coarsening of grain of castings poured from such metal, the coarsening increasing with prolongation of the time that the metal is molten.

The fact that soaking at elevated temperatures produces detrimental effects in a relatively short time while, at a low temperature, 24 hours' duration produces no such effects, again argues for low melting temperatures.

Effect of Previous History of Metal.

The question naturally arises whether metal which has been damaged by any of the treatments described above can be corrected. It has been found that complete correction of the effects described can be brought about by casting the damaged metal and remelting. Metal which has been heated to 930 deg. C., and poured, and is therefore suffering from coarse grain size, can be made normal again by carefully remelting.

Grain Refinement and Control.

Now, quite apart from the influence of melting and pouring temperatures upon grain size, recent research has shown that the grain size of aluminium alloys (in fact, of many other alloys also) can be controlled to a remarkable extent by a number of relatively new methods. Small grain size is advantageous from the point of view of mechanical strength, corrosion resistance, ammenability to heat-treatment and reduction of foundry troubles such as cracking and drawing. The workability of Al alloys is also improved thereby.

Grain refinement can be brought about by a number of means, principal among which are the introduction into the molten alloy of some such substances as boron, titanium, vanadium and other similar elements. These elements exert an effect by virtue of their high power of nuclear formation.

In a patented modification of this process the molten metal is first treated with chlorine, which removes impurities such as carbides, nitrides and oxides, which lead to corrosion and weakness of alloys containing them. The chlorine treatment coarsens the grain, but by a subsequent treatment with a refining element the grain size is reduced to very small dimensions.

Index to British Standard Specifications.—The British Standards Institution has issued its half-yearly handbook, which includes a list of the British Standard Specifications covering 40 pages, and includes both a numerical list and a complete subject index of B.S. Specifications. Copies can be obtained from the British Standards Institution (Publication Department), 28, Victoria Street, London, S.W.1, price 1s. 2d. post free.

The Sun and Planet Friction Eliminator.

Ball and roller bearings may be classified under two broad headings, journals used for the support of loads perpendicular to the axis of rotation, and thrust bearings to carry axial loads. The sun and planet principle, recently introduced by the Hoffmann Manufacturing Company, Limited, Chelmsford, Essex, opens up an entirely new field of importance for the application of ball and roller bearings, it being particularly adapted for sliding and reciprocating mechanisms, where hitherto it has been impossible to use satisfactorily ball or roller bearings.

Briefly, the standard eliminator comprises a contact or load ball or roller free to rotate about its own axis and superimposed eccentrically on a freely rotating raceway or track, the whole being suitably housed in complete unit form. Referring to the drawings, Fig. 1 represents one of a series of complete units capable of carrying loads of from 250 to 6,000 lbs. and designed to operate with reciprocating mechanisms. A is

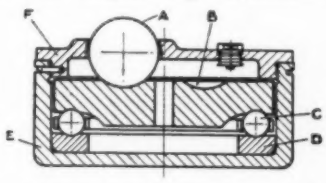

Fig. 1.—Ball-Bearing Friction Eliminator.

the contact or load ball, B the raceway or endless track which rotates on the balls C running on the fixed raceway D. The housing E has a removable plate F having a hole eccentrically disposed to position the contact ball. When a tangentially moving load is applied to the top of this contact ball by either a flat or grooved track, it rolls on the endless track without perceptible frictional contact with the plate F, resulting in a load carrier of an almost frictionless nature.

Fig. 2 illustrates one of a series of simple roller forms of the eliminator designed to carry loads of from 1,500 to 7,500 lbs. In this type the contact roller A is eccentrically mounted above and in contact with two rotating raceways or tracks B and B_1 arranged concentric with one another. These tracks revolve on the balls

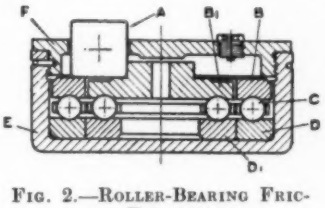

Fig. 2.—Roller-Bearing Friction Eliminator.

C running on the fixed raceways D and D_1. The housing E has a removable plate F, provided with an eccentrically-disposed hole to position the contact roller A. In this type the roller makes contact with separate races, thus allowing it to revolve in a frictionless manner, while each track revolves at its appropriate speed.

The two forms illustrated offer to designers complete units requiring the minimum amount of fixing and capable of operating with sliding and reciprocating mechanisms with the same efficiency as is obtained with ball and roller bearings in revolving mechanisms. These eliminators occupy very little depth compared with their load-carrying capacity, and have the further advantage of being self-contained and oil retaining. Although the simple forms shown are intended to operate in a substantially straight line, other modifications allow of multi-directional movement.

Competitive Condition of the Iron and Steel Industry.

NATIONAL SCHEME PREPARED AND SUBMITTED.

In the course of an address on "The Position of our Basic Industries from the National and International Points of View," given by Mr. Charles Mitchell (chairman of the National Committee for the Iron and Steel Industry), at a meeting of the London Iron and Steel Exchange in London recently the speaker said the position of the iron and steel industry to-day was entirely different from what it was in 1914 because the general upheaval following the war had created conditions in the industry which demanded that it should be dealt with in a very different manner from that in which it was dealt with in pre-war days. The industry at that time had been built up to a very large extent on what was known as individual effort. We had certain markets as our monopoly and, indeed, certain firms had certain markets as their monopoly, and the result was that the keen competition between individual firms brought about a position, more or less, of the survival of the fittest. Reasonable profits were made and those who could not make reasonable profits naturally went to the wall.

Since the war, however, the iron and steel industry in this country as a whole had been fighting a steadily losing battle. France and Belgium, largely owing to monies at their disposal from reparations, and Germany largely by the aid of monies borrowed from the United States, had consolidated the iron and steel industry in their respective countries to a degree which was in advance of the position in this country. Because of the manner in which the case for the iron and steel industry was represented to the public, and, secondly, because this country was for a period of years the free dump of Europe, manufacturers could not find the money necessary to re-equip their works, and we found ourselves having to meet intensive competition from the Continent, which brought with it a dwindling market.

Recently, however, the situation had changed in some respects. The Government had come to the aid of the industry and at least given it a breathing space. Nevertheless, it was incumbent upon the industry to do something. Looking at the industry from a national point of view, and bearing in mind the altered conditions, it was essential that something should be done within the industry, and he said quite frankly that the old idea of individual ownership must definitely go and by co-operation an endeavour must be made, first to bring down the cost of production to a degree which could enable the consumer to be supplied at a reasonable price, and, secondly, to regain our rightful position in the world's markets. From the international point of view the consolidation of the industry in this country would immediately place us in a very strong position because we should be able to bargain with our competitors throughout the world on the basis of price, and, in addition, we had the further weapon of the tariff with the aid of which it would be possible to make our competitors take a very different view of things. Unless the industry was consolidated, however, it would be useless to enter into any international agreement. We had to look to the export side of business in order to live, and as it had been very well put recently, we must either export or expire. Obviously we could not compete in the world's markets unless we produced the material at the right price.

Referring to the work that was being done by the National Committee for the reorganisation of the iron and steel industry, Mr. Mitchell said it was common knowledge that the two years' extension of the tariff was, as it were, conditional on the industry putting its own house in order, and although nothing had yet been published it would do no harm if he stated that a scheme had been prepared and submitted. Broadly speaking, that scheme set out with the idea that in order to bring down the cost of production it was essential to concentrate the production of iron and steel at those units which for geographical reasons, for reasons of natural resources or because of labour conditions or any other factors, were the most desirable for the purpose of manufacturing a particular product.

Following that, the endeavour had been to see that the consumers' interests were fully safeguarded. It had to be recognised that over a period of years many consumers had benefited by the extraordinary low prices of material dumped into this country at a cost less than the cost of production in the country of origin. It was, however, no use saying to these people that now the industry had secured protection they must pay a higher price because the material could not be made in this country as cheaply as it was abroad. That would be impossible, because it might result in a particular consumer losing a particular market in which this cheap iron and steel formed the raw material, and then that manufactured article could not in turn compete in the world's markets. Therefore, the Committee had tried as far as possible to see the problem from the point of view both of the producer and of the consumer, and he hoped they had succeeded.

When the scheme was published he believed it would be agreed that it was at least a step in the direction of bringing about the consolidation of an industry vital to the country. Furthermore, he hoped it would induce the public to put both money and faith into the industry and so give it a reasonable chance of showing that it could regain what it had lost during the past ten years when it had been fighting such a losing battle.

Mr. James Whitby, who proposed a vote of thanks to Mr. Mitchell, expressed the view that we were not spending sufficient in this country on the selling side of the industry.

Mr. R. A. Skelton said that the alteration in the conditions of the iron and steel industry which had been referred to had not arisen only since the war, because long before the war, difficulties in competing with other countries had been experienced, and the chasm between our prices and those of other countries had continually widened since then. Commenting upon the effect of cheap imported steel in relation to other industries in which this was used as a raw material, Mr. Skelton claimed that they had lost much more in the industries using this material than was represented by the extent to which imports had been restricted by tariffs. Finally, on the question of salesmanship, he expressed the view that the standard in other countries was very much lower than ours, and that we had failed because we had tried to sell £6 per ton material when somebody else was offering similar material at £4 per ton.

Mr. F. W. Harbord, after suggesting that it must be obvious that a country paying lower wages and working longer hours could supply more cheaply than our own manufacturers, assuming the conditions of efficiency and cost of materials to be the same, pointed out that there was room in the industry for considerable improvement in matters of detail such as fuel economy, etc., notwithstanding the great strides made in these directions since the war. Further, the question of capital costs should be carefully watched in relation to new construction, because, although many things were desirable, they were not absolutely essential, and therefore every possible economy from the capital expenditure point of view, consistent with efficiency, should be practised.

Mr. Needham deprecated a position in which he said they were trying to make the export market buy open-hearth steel at a price much higher than basic-Bessemer steel could be purchased from the Continent. If this steel was good enough in certain markets, then it seemed that we should have to adopt the Bessemer process in this country and make a cheap-grade steel in order to enter the export market and get back business which was now strongly in the hands of the French and the Belgians.

Mr. Mitchell, replying to the comments that had been made, informed Mr. Harbord that, although there might have been a certain laxity on the scientific side in the past, the industry was now fully alive to the necessity for research, and everything that was humanly possible was being done to equip our works in the most scientific and up-to-date manner. The question of whether we ought to produce a low-grade type of steel comparable with what the Continental countries were shipping abroad was receiving the closest attention, but on the general question of a reduction in price he himself had strongly advocated that this should not be done by 2s. 6d. per ton here and 2s. 6d. per ton there. We should wait until a really substantial reduction could be made. Ironical as it might seem, the aim at the moment was to produce a higher-grade steel rather than a lower grade in order to reduce the amount required for any particular building or machine. That would bring down the price of the building or machine, and, it was hoped, lead to a great demand for steel for those purposes. At the same time, he agreed we might be faced with the necessity for producing a very cheap steel here or import it.

British Electrical and Allied Manufacturers' Association.

The annual meeting of the British Electrical and Allied Manufacturers' Association was held at the offices of the Association, 36, Kingsway, London, W.C.2, recently, the Chairman of the Council, Mr. M. J. Railing, presiding.

Mr. Railing, in his address, said it was gratifying to be able to report that the Association was more and more consulted by the Government and outside bodies. They had been consulted in connection with tariff legislation, and even if their advice had not always been taken, and if they had not benefited as much as they would like, the all-round benefit which the new tariffs had conferred was bound to reflect in the long run on the electrical industry as well. The Association had also been consulted at the time of the Ottawa Conference. At Ottawa the British Government had agreed to put a duty on copper. It was largely due to the stand which the Cable Makers' Association took in co-operation with the Beama that the Government was induced to postpone the imposition of the duty until it was advised by a committee composed of consumers and producers. As a result, he could assure them that no duty would be put on copper if any such duty made it difficult for British industry to obtain sufficient quantities of the right quality at the right price.

The Association, concluded Mr. Railing, had now completed 21 years of work. It was more necessary now than ever before that it should be strong. World conditions were not what they would like them to be, but considering the world position of the electrical industry he felt that, notwithstanding the bad times, they in this country had every reason to congratulate themselves.

Messrs. Dorman, Long & Company, Limited, have been requested to state that Mr. Edwin (Eddie) Davies, formerly employed by them in their London office and previously by Messrs. Bolckow, Vaughan & Company, Limited, is in no way connected with the recent case of alleged forgery at Middlesbrough in which another employee of the same surname was concerned.

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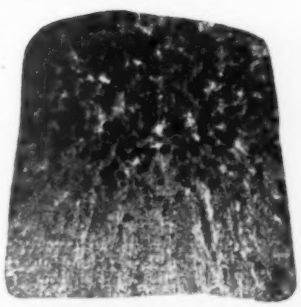

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ARMSTRONG CLOSE WORKS — SIR W. G. ARMSTRONG WHITWORTH & Co. (Ironfounders) LIMITED — WHITWORTH GATESHEAD ON TYNE

TELEGRAMS "CLOSEWORK, GATESHEAD"

This Week's News in Brief.

Trade Talk.

Messrs. Richard Thomas & Company, Limited, announce their decision to reopen immediately the Redbourne Iron and Steel Works at Scunthorpe, Lincs.

Messrs. Richardsons, Westgarth & Company, Limited, Hartlepool, have secured an order from Messrs. Smith's Dock Company, Limited, for 10 marine boilers, each with three furnaces.

Mr. C. H. V. Wilson, of Messrs. William Cumming & Company, Limited, informs us that on and after April 1, 1933, his address will be 36, Lynette Avenue, Clapham Common, London, S.W.4.

The twenty-second annual general meeting of the German Foundrymen's Technical Association will be held in Berlin on Saturday evening and Sunday, June 10 and 11.

The employees of Duncan Stewart & Company, Limited, London Road Ironworks, Glasgow, have contributed the sum of £157 to Glasgow and West of Scotland charitable institutions.

The Ford Motor Company, Detroit, is using soya oil in its foundry for core-making purposes. It is claimed that soya oil is more satisfactory than linseed oil and 25 per cent. cheaper.

Employment for 150 men has been provided by the resumption of operations at three tinplate mills of the Gwalia Tinplate Works, Briton Ferry, owned by Messrs. Gwynne & Company (1926), Limited.

The North British Locomotive Company, Limited, Hydepark, Glasgow, have secured an order for five locomotive boilers for the Madras and Southern Mahratta Railway Company, Limited, India.

The employees of Messrs. Smith & Wellstood's foundry at Bonnybridge, Stirlingshire, have made contributions to infirmaries and other charitable institutions totalling £403 2s., of which £203 15s. 7d. went to Falkirk Royal Infirmary.

Messrs. P. & W. Maclellan, Limited, have received the contract for the supply of the steelwork for a new building to be erected at the entrance to St. Enoch Square, at Argyle Street, Glasgow. The building is to cost £16,177.

Messrs. Dorman, Long & Company, Limited, put into blast recently an additional furnace at their South Bank Works, Middlesbrough. This brings the total number of furnaces working in the North-East up to 18. The furnace will produce ferro-manganese.

The annual report of the Cunard Steam Ship Company states that the structure and machinery of s.s. "No. 534," the ship on which work has been suspended at Clydebank, have been maintained in perfect condition, and that negotiations which may lead to a resumption of work are in progress.

A fire occurred in the pattern shop of Messrs. George Oxley & Sons, Limited, Vulcan Foundry, Attercliffe Road, Sheffield, early on Saturday morning. The contents of the shop were mainly destroyed, but arrangements have been made for the loss to be quickly made good.

The annual dinner of the Chemical Engineering Group of the Society of Chemical Industry will be held on Friday, April 28, 1933, at the Waldorf Hotel, London. The Rt. Hon. Lord Melchett is to be principal guest of the evening and will deliver an address on "Modern Economics and Unemployment."

The joint secretaries of the Scottish Manufactured Iron Trade Conciliation and Arbitration Board have received intimation from the auditor that the net selling price for January and February, 1933, was £9 19s. 4.79d., which means that the wages of the workers will be increased by 2½ per cent. on basis rates.

It is reported that the Chinese Government Purchasing Commission, in connection with the Boxer indemnity scheme, has concluded negotiations for improvement and extension of the Hongchow-Kiangshan railway. Contracts have just been placed in London for six locomotives, 7,000 tons of rails, 34 passenger carriages, 50 wagons and a large amount of miscellaneous stores. One of the next most important developments in the immediate future is the completion of the Canton-Hankow railway, a stretch of 240 miles in very mountainous country connecting Peking with Canton. This work will cost from £3 to £4 million.

The Chinese Government Purchasing Commission (London), in connection with the British Boxer Indemnity for the purchase of railway and engineering material in Great Britain, has placed orders for equipment for the Hangchow-Kiangshan railway, which includes:—Twenty-four passenger carriage underframes from Messrs. Hurst, Nelson & Company, Limited, Motherwell; sixteen 15-ton all-steel covered-type and 24 open-type wagons from Messrs. R. Y. Pickering & Company, Limited, Wishaw; and 10 flat-type wagons from Messrs. Hurst, Nelson & Company, Limited, Flemington, Lanarkshire.

Prof. Henry Louis, a Past-President of the Iron and Steel Institute, commenting on the Continental preference for basic-Bessemer steel in an address to the members of Tees-side Chamber of Commerce, at Middlesbrough, recently, said that for certain purposes he would just as soon use basic-Bessemer as any other kind. Steel that was good enough for its job if it was cheap enough was what the nations of the world would go for, and it was on those lines that the British iron and steel industry should develop. We had been the leaders of the iron and steel industry of the past, and there was no reason why we should not be again, but we had to adapt ourselves anew to suit the conditions.

A demonstration of modern steam wagons is to be given daily between 2 and 4 p.m. on April 4, 5 and 6, outside the Victoria Tower of the Houses of Parliament. All the firms manufacturing steam road vehicles are co-operating and every member of both Houses is being invited by the Coal Utilisation Council to examine them. The demonstration will be followed on April 6 by a rally of steam vehicles sent specially by satisfied users from all over the country and assembled at noon on some open space in Central London approved by the authorities. The modern steam wagon is silent, smokeless, efficient and inoffensive, being pneumatic-tyred and mechanically stoked with smokeless steam coal.

Messrs. William Denny & Bros., Limited, Leven Shipyard, Dumbarton, have received an order from the London Midland & Scottish Railway for the construction of a new steamer with passenger and cargo accommodation, for service on the Larne-Stranraer route. The vessel, which will replace the "Princess Victoria," will be 330 ft. in length, 49-ft. breadth, and 17-ft. moulded depth, and will be about 2,900 tons gross. The propelling machinery will consist of high-pressure turbines designed to give the vessel a service speed of 20 knots. Steam will be supplied from Babcock & Wilcox water-tube boilers, and the vessel is expected to be placed in commission in the beginning of 1934.

A notable achievement in steel melting is recorded by the United Steel Companies, Limited, at their Appleby Iron Company, Limited, plant at Scunthorpe. Two weeks ago it was found necessary to meet an exceptional demand for steel ingots for the firm's plate mill. With the co-operation of the furnace crews and all other workers in the steel-melting plant, the 300-ton steel-melting furnace, which is of the tilting variety, was put to its maximum production. In the six days ending March 18 a production of 2,595 tons was achieved; there were 11 tappings of the furnace, each comprising three ladles of molten steel containing approximately 78 tons. In the week ending March 25 the production from this one furnace was 2,515 tons.

On the Continent ferro-silicon prices are controlled by the Ferro-Silicon Syndicate of Vienna, which deals in ferro-silicon of from 30 to 95 per cent. Si inclusive. Current quotations for Germany are:—45 per cent., 205 to 215 Rmks.; 75 per cent., 320 to 340 Rmks.; and 90 per cent., 410 to 435 Rmks. per ton delivered. The Syndicate controls seven selling agencies in Germany, each of which supplies its own class and list of customers, principally steel-works and foundries. To fill orders at short notice, stocks are kept available at Duisburg and elsewhere. The chief ferro-silicon producers in the syndicate have works in Germany, Sweden, Norway, Denmark, Austria, Switzerland and Jugo-Slavia. The French producers have their own syndicate, operating in accord with the Vienna syndicate under a special agreement.

Personal.

Councillor J. Taylor was re-elected chairman of the Cleveland District Delegate Board of the National Union of Blastfurnacemen, Ore Miners, Coke Workers, and Kindred Trades, at their half-yearly meeting in Middlesbrough.

Wills.

Stevenson, Harry, director of the British Oxygen Company, Limited £31,532

Hughes, L., of Liverpool, chairman of Messrs. Perrin, Hughes & Company, Limited, brassfounders £26,754

Carter, Walter, a director of Messrs. J. J. Saville & Company, Limited, Triumph Steel Works, Sheffield ... £16,124

Rankin, Matthew, of Messrs. Rankin & Blackmore, Limited, Eagle Foundry, Greenock £218,477

Gilchrist, A., chairman of Messrs. Barclay, Curle & Company, Limited, Glasgow, a director of Swan, Hunter & Wigham Richardson, Limited, the Glasgow Iron & Steel Company and the Whiteinch Galvanising Company, Limited £39,633

Company Reports.

A. Reyrolle & Company, Limited.—Dividend of 12½ per cent. on the ordinary shares for the year 1932.

Associated Electrical Industries, Limited.—Dividend of 4 per cent. on the ordinary shares for the year 1932.

Edgar Allen & Company, Limited.—Payment of the dividend on the cumulative preference shares in respect of the half-year ending March 31, 1933, is deferred.

Vickers-Armstrongs, Limited.—Profit, £160,717; brought in, £75,792; "A" preference dividend for six months ended April 30, 1930, £160,120; carried forward, £76,389.

Vickers, Limited.—Net trading profit, £811,593; income tax, debenture interest, etc., £282,555; dividends on preference share capital, £418,190; brought in, £234,329; dividend of 4 per cent. on the ordinary shares, £123,154; carried forward, £222,022.

Steel Company of Canada, Limited.—Net profit for 1932, $217,425; deficit, after paying four quarterly dividends of 7 per cent. per annum on the preference shares and of $1.75 per share on the ordinary shares, $1,042,315, reducing the surplus to $12,753,772.

Coltness Iron Company, Limited.—Profit, £184,514; provision for income tax, £24,000; written off for redemption and depreciation, £60,000; brought in, £156,172; interim dividends already paid, £36,500; dividends for six months to January 31, 1933, on the first and second preference shares, £12,875; final dividend on the ordinary shares of 5 per cent., making 8 per cent. for the year, £39,375; carried forward, £164,337.

Baldwins, Limited.—Profit, £190,599; brought in, £1,089; depreciation, £60,000; special expenditure at collieries, £5,659; income tax, £5,727; directors' fees, £4,707; interest on 6 per cent. first mortgage debenture stock, £59,283; interest on 6½ per cent. "A" debenture stock, £74,974; sinking fund for 6 per cent. debentures, £10,471; carried forward, £29,135. The British (Guest Keen Baldwins) Iron & Steel Company, Limited, showed a manufacturing profit of £161,469, against which £123,359 was charged for interest, special expenditure, depreciation, etc., leaving a net profit of £38,109, which compares with a profit of £9,890 for 1931.

Contracts Open.

Cleethorpes, April 8.—Forty-six street-lighting standards, for the Urban District Council. Mr. L. W. Pye, engineer, Council Offices, Cleethorpes.

Johannesburg, April 20.—Thirty miles of braided cable, with copper conductors, for the Johannesburg City Council. The Department of Overseas Trade. (Reference A.X. 11,724.)

Southport, April 11.—Three electrically-driven centrifugal pumping sets, for the Southport and District Water Board. Mr. C. Burton Ede, manager, 14, Portland Street, Southport. (Fee £3 3s., returnable.)

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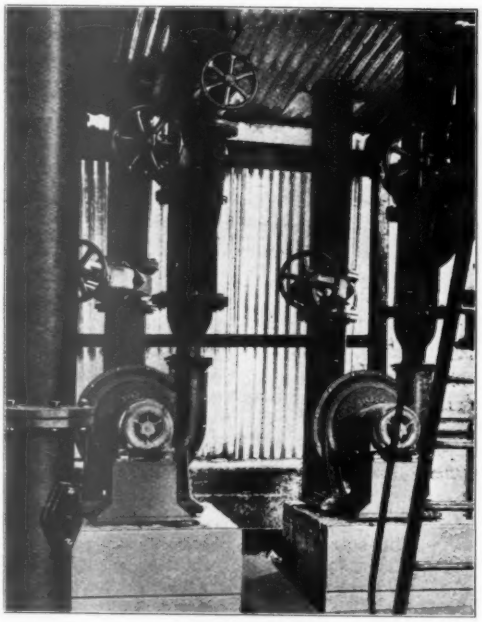

No. S.F. 26 dealing with "Sirocco" Fan Manufactures for moderate and high pressures. It includes some interesting examples of recent installations and contains detailed and accurate information concerning duties, weights and dimensions for the wide range of sizes and designs listed. In addition, numerous tables assist in determining the most suitable "Sirocco" Fan Equipment for use under diverse operating conditions.

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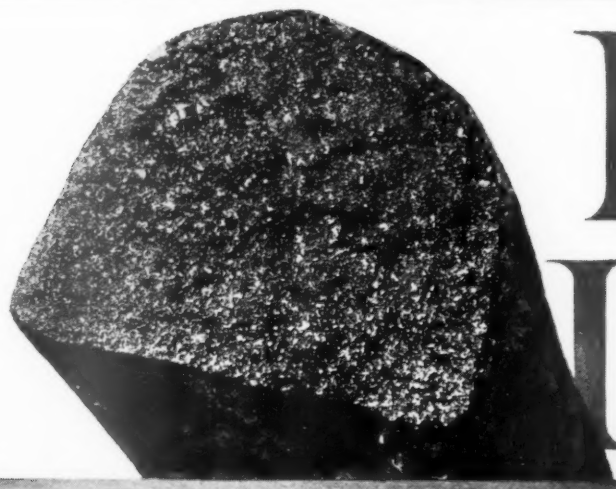

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DORMAN LONG

Raw Material Markets.

A gradual improvement seems to be making itself felt in the iron and steel markets. Reports from several of the pig-iron consuming districts indicate an increasing, if irregular, demand. Although requisitions from the foundries are still limited, the latter are showing more confidence in the future. The Cleveland iron trade, in particular, is showing increased activity. On the whole, the heavy trades show little improvement, but there are a few more orders for shipbuilding material about.

Pig-Iron.

MIDDLESBROUGH.—Prospects in the local pig-iron market are much improved. Local consumption is slowly increasing, although the foundries are still reluctant to buy forward. Shipments of pig-iron from the Tees last month amounted to 15,465 tons, the heaviest total for twelve months. Coastwise shipments amounted to 11,141 tons, of which 10,036 tons went to Scotland, which only took 1,457 tons in February. Messrs. Dorman, Long restarted a furnace on ferro-manganese at South Bank last week. There are now 18 furnaces in blast on the North-East Coast, as compared with 15 at the beginning of March. There has been no change in official quotations.

East Coast hematite is in freer demand. In addition to the usual despatches to Sheffield and South Wales, several thousand tons have been sold to Scottish consumers. Recent export business includes several large orders from Japan. Realised home prices have averaged 59s. per ton for mixed numbers, f.o.t. or f.o.b., with No. 1 quality at 59s. 6d.

LANCASHIRE.—Sales of pig-iron in this area remain at about recent levels, it being difficult to visualise any great increase in business while the present supplies of cheap scrap remain in evidence. Few pig-iron orders for more than a month ahead have been secured. Prices are firmly maintained all round. For delivery to users in the Manchester zone, Derbyshire and Staffordshire brands of No. 3 iron are on offer on the basis of 67s. per ton, with North-East Coast iron nominally quoted at about the same figure. Northamptonshire No. 3 is maintained at 65s. 6d. per ton, with Scottish foundry at around 82s., West Coast hematite at about 80s. 6d. and East Coast hematite at 5s. less.

MIDLANDS.—The consuming industries in this area are making little progress, particularly in the heavy engineering sections, and the furnaces are still having to put iron into stock. The present prices for Midland brands of iron delivered to Birmingham and Black Country stations are 62s. 6d. for Northants No. 3 and 66s. for Derbyshire, North Staffordshire and Lincolnshire No. 3. Cleveland No. 3, of which limited supplies are coming through, can also be obtained at the Derbyshire level. With regard to hematite, slight concessions could be obtained from the N.E. Coast or South Wales on present levels, which range from 73s. to 77s. 6d. per ton delivered this district. West Coast iron remains at the controlled level of 84s. 6d. for No. 3 and mixed numbers. Moderate supplies of Scottish No. 3 iron are used by special trades in this district, the price ranging from 82s. 6d. to 85s. delivered. Other medium- and low-phosphorus irons from other districts, of which fair tonnages are used, range from 69s. to 80s. delivered Birmingham district.

SCOTLAND.—The relighting of another two furnaces, one on hematite and one on foundry, brings the total number in blast up to seven—four on foundry iron, two on hematite and one on basic. This increase in production is due more to the necessity of replenishing depleted stocks than to any increase in business. There is little improvement in activity at the Clyde foundries, although sugar-machinery makers are extremely busy. There is no change in pig-iron prices and the official minimum of 65s. for No. 3 Scottish foundry is still in force, with 2s. 6d. extra for No. 1. No. 3 Middlesbrough is offered at 62s. 9d. Glasgow area and 59s. 9d. Falkirk area. Other English No. 3 foundry is obtainable at 57s. 3d. f.o.t. Falkirk. Scottish hematite is at 66s. and West Coast hematite at 68s. 6d.

Coke.

Little improvement occurs in the position of foundry coke. Orders are small and almost entirely for immediate delivery, and there are no signs of any returning confidence in the future. Best Durham coke is offered at 36s. 6d. to 38s. per ton, other grades being at down to 35s., while quotations for Welsh coke range from 30s. to 46s. per ton, according to analysis, delivered in the Birmingham area.

Steel.

Following the European Steel Cartel developments, Continental works withdrew from the market, leaving the British makers in a stronger position. Many buyers, however, have adopted a waiting policy. Business in the semi-finished steel market has improved lately, and some of the British works are fairly busy on this class of material. Continental competition in this department has practically ceased, so far as the home market is concerned. The finished-steel market has been fairly active of late. Export inquiry has increased in volume, and buyers in some markets have shown a greater inclination to come to terms.

Scrap.

Following the recent activity, there has been a reaction on the Cleveland scrap-iron market, and ordinary heavy cast iron does not now realise more than 42s. 6d., whilst machinery metal is quoted at 45s., delivered. Light cast iron is down to 38s. per ton. There continues to be a steady demand for cast-iron scrap in the Midlands, where heavy machinery metal in handy sizes is quoted at 47s. 6d., heavy pipe and plate scrap at 42s. 6d. and light cast iron at 40s., delivered works. There is still a good demand in South Wales for light cast iron at 39s. to 40s., but both heavy and machinery metal are quiet at 43s. to 44s. and 48s. to 50s. per ton respectively. In Scotland, best heavy machinery cast-iron scrap, in pieces not exceeding 1 cwt., is at 50s. to 51s., ordinary cast iron to the same specification being at 46s. 6d. to 47s. 6d. per ton, delivered.

Metals.

Copper.—Trading in copper has been very restricted, and prices have been slightly easier. Little buying by consumers has been seen, and speculative buying has not been very noticeable, owing to the doubtful prospects of the market at the moment. Proposals have been renewed from this side of the Atlantic for a *rapprochement* with the American producers, with a view to a return to control of output, but it is very doubtful whether anything will come of them. The future of the market largely depends upon an increase in industrial consumption, to the least sign of which prices would show a ready response.

Prices have been :—

Cash.—Thursday, £28 2s. 6d. to £28 5s.; Friday, £28 5s. to £28 6s. 3d.; Monday, £28 3s. 9d. to £28 5s.; Tuesday, £28 1s. 3d. to £28 2s. 6d.; Wednesday, £28 5s. to £28 6s. 3d.

Three Months. — Thursday, £28 8s. 9d. to £28 10s.; Friday, £28 11s. 3d. to £28 12s. 6d.; Monday, £28 10s. to £28 11s. 3d.; Tuesday, £28 7s. 6d. to £28 8s. 9d.; Wednesday, £28 10s. to £28 11s. 3d.

Tin.—The market has shown a steady appearance, based upon the fair rate of consumption which is being maintained, particularly in the tinplate industry, and to the improving statistical position. New business has been very small.

Prices of standard tin have been :—

Cash.—Thursday, £150 12s. 6d. to £150 17s. 6d.; Friday, £151 2s. 6d. to £151 7s. 6d.; Monday, £151 7s. 6d. to £151 10s.; Tuesday, £152 to £152 5s.; Wednesday, £153 10s. to £153 12s. 6d.

Three Months. — Thursday, £151 10s. to £151 12s. 6d.; Friday, £152 to £152 5s.; Monday, £152 7s. 6d. to £152 12s. 6d.; Tuesday, £153 to £153 2s. 6d.; Wednesday, £154 7s. 6d. to £154 12s. 6d.

Spelter.—Prices have been steady. Messrs. Rudolf Wolff & Company report that "there is no scarcity of supply for consumers' requirements. Trade demand in this country continues quiet and the earlier weakness may be ascribed to this reason and to lack of interest on the part of buyers generally, holders at the same time showing a little more disposition to effect sales. The market on the Continent is also reported quiet, with little indication of any broadening in general industrial demand; sellers, however, have displayed no anxiety and sales have consequently been light. In the United States of America the market remains quiet, with a slightly easier tendency, due to continued restricted demand on the part of consumers."

Price fluctuations :—

Ordinary.—Thursday, £14 16s. 3d.; Friday, £14 17s. 6d.; Monday, £14 7s. 6d.; Tuesday, £14 8s. 9d.; Wednesday, £14 8s. 9d.

Lead.—"Consumptive demand is maintained and manufacturers here report business as on a satisfactory scale," states Messrs. Henry Gardner's report. Slightly better conditions are being seen in the cable-making industry. The undertone of the market is fairly firm at the moment.

Daily market prices :—

Soft Foreign (Prompt).—Thursday, £10 8s. 9d.; Friday, £10 10s.; Monday, £10 10s.; Tuesday, £10 7s. 6d.; Wednesday, £10 6s. 3d.

The Heat Reactions Involved in the Treatment of Cast Iron with Soda Ash.

(*Concluded from page* 240.)

comes into contact with the superheated metal and with the silica resulting from the oxidation of silicon in the molten cast iron. Whilst in this zone the reactions have just begun to function, it is only when the soda descends into the well of the cupola, intermingling with the slag now covering the molten bath of cast iron, that the more intimate contact between the soda and the silicon, manganese and sulphur finishes its work.

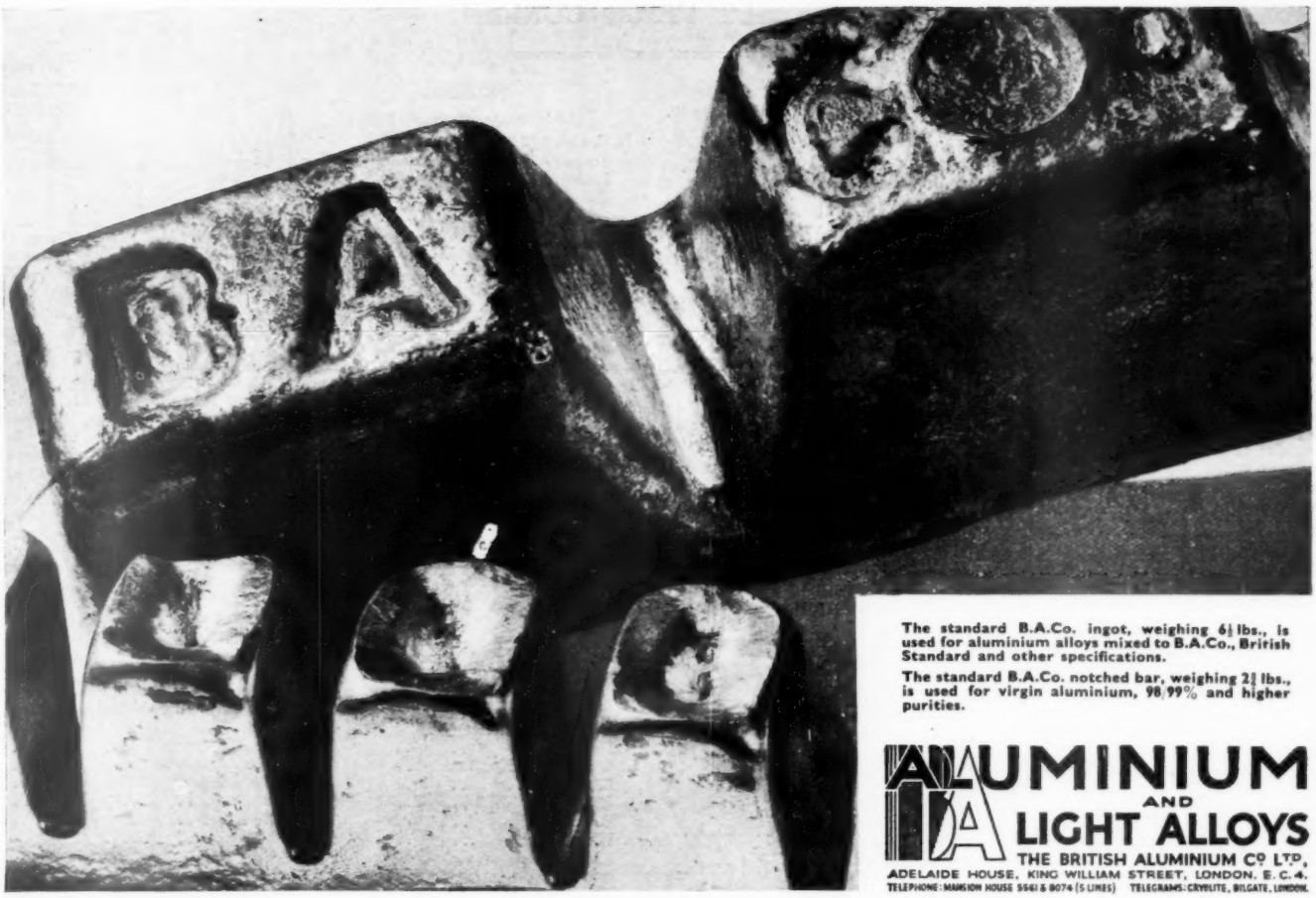
It is obvious that the reactions are most vigorous in the horizon of contact between the metal in the well and the slag overlying it. The desulphurising reaction cannot be of the same effectiveness as in the case where the powdered soda ash is placed in the ladle and the molten metal poured over it. The activity of the desiliconising reaction is greatly increased in the slag zone, the removal of silicon from the molten cast iron being from 50 to 100 per cent. greater than in the ladle method.

More soda is required to form, with the additional silica available, a greater weight of sodium silicate, the amount of heat generated being proportionally increased. The effect of the hot and very fluid slag on the underlying metal must be beneficial, enabling gaseous and non-metallic impurities to rise into the slag. When using 1 lb. of soda-ash blocks per 100 lbs. of cast iron the balance of the sodium available for the sodium-flame reaction will be less than in the ladle method, and there is some doubt whether the flame action is complete in the presence of the CO and CO_2 gases in the tuyere zone of the cupola.

The heat reactions are, of course, the same whether the soda ash is added to the cupola charges or to the molten metal in the ladle, but in the former case the metal temperature is not lowered by reason of the CO_2 expulsion. The inter-reactions between the nascent soda and the sulphur and silicon in the metal lying in the well of the cupola are not affected by any cooling actions, and practice proves that in these circumstances the silicon lost by the metal is some 50 per cent. higher than in the metal treated by soda ash in the ladle.

There cannot be so thorough a mixing of the metal and soda in the cupola well as in the ladle, where the expelled CO_2 vigorously agitates the metal as the gas bubbles ascend to the surface of the metal. When 1 lb. of soda ash is added per 100 lbs. metal in the cupola charges, the temperature of the metal as estimated will be about 43 deg. F. higher than when the same weight of soda ash per 109 lbs. of cast iron of similar analysis is added to the ladle.

In recent tests where cast iron of approximately the same analysis as that shown for the metal—cast iron A (referred to above)—was treated, both cupola and ladle methods were used, and the general impression of the foundry people present was that the cupola-treated metal was hotter than that treated in the ladle. The percentage of sulphur removed from the ladle-treated metal was approximately twice that from the cast iron treated in the cupola by means of soda-ash block additions. The writer's observations in foundries where the soda-ash treatment is practised support the conclusions arrived at as a result of the foregoing investigation of the heat reactions involved in the soda-ash process of treating cast iron.



The standard B.A.Co. ingot, weighing 6½ lbs., is used for aluminium alloys mixed to B.A.Co., British Standard and other specifications.

The standard B.A.Co. notched bar, weighing 2½ lbs., is used for virgin aluminium, 98/99% and higher purities.

ALUMINIUM AND LIGHT ALLOYS

THE BRITISH ALUMINIUM Co LTD,
ADELAIDE HOUSE, KING WILLIAM STREET, LONDON, E.C.4.
TELEPHONE: MANSION HOUSE 5561 & 8074 (5 LINES) TELEGRAMS: CRYOLITE, BILGATE, LONDON.

CAST IRON FLANGED PIPES
2 in.—12 in. & CONNECTIONS. to 24 in. dia.
WE HAVE FIFTY-TWO YEARS OF ACCUMULATED EXPERIENCE AND METAL PATTERNS.
JAMES & RONALD RITCHIE, LTD.,
Telephone: 3852 (2 Lines). MIDDLESBROUGH. Telegrams: "Ritchie, Middlesbrough."

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	28	5	0
Three months	28	10	0
Electrolytic	32	0	0
Tough	30	0	0
Best selected	30	10	0
Sheets	61	0	0
India	39	15	0
Wire bars	32	7	6
Do., May	32	6	3
Do., June	32	5	0
Ingot bars	32	7	6
H.C. wire rods	35	0	0
Off. av. cash, March	28	4	4 1/2
Do., 3 mths., March	28	9	10 1/2
Do., Sttlmnt., March	28	4	2 1/2
Do., Electro, March	32	13	3
Do., B.S., March	31	0	3 1/2
Do., wire bars, March	32	17	2
Solid drawn tubes			9 1/2d.
Brazed tubes			9 1/2d.
Wire			6 1/2d.

BRASS.

Solid drawn tubes	8 1/2d.
Brazed tubes	10 1/2d.
Rods, drawn	7 1/2d.
Rods, extd. or rlld.	4 3/4d.
Sheets to 10 w.g.	7 1/2d.
Wire	7 1/2d.
Rolled metal	7d.
Yellow metal rods	4 1/2d.
Do. 4 × 4 Squares	5 1/2d.
Do. 4 × 3 Sheets	5 1/2d.

TIN.

	£	s.	d.
Standard cash	153	10	0
Three months	154	7	6
English	154	15	0
Bars	155	15	0
Straits	157	15	0
Australian	155	10	0
Eastern	158	0	0
Banca	159	0	0
Off. av. cash, March	149	4	1 1/3
Do., 3 mths., March	149	18	1 1/3
Do., Sttlmt., March	149	4	1 1/3

SPELTER.

	£	s.	d.
Ordinary	14	8	9
Remelted	14	0	0
Hard	12	0	0
Electro 99.9	17	0	0
English	15	5	0
India	13	10	0
Zinc dust	19	10	0
Zinc ashes	2	5	0
Off. aver., March	14	13	2 1/3
Aver. spot, March	14	12	11 6/3

LEAD.

	£	s.	d.
Soft foreign ppt.	10	6	3
Empire	10	12	6
English	11	15	0
Off. average, March	10	14	3 1/3
Average spot, March	10	12	2 3/3

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	24	0	0
Do., V.M. ex-whse.	23	0	0
Rods	26	0	0
Boiler plates	22	0	0
Battery plates		—	

ANTIMONY.

English	37 10 0 to 42 10 0
Chinese	26 15 0
Crude	—

QUICKSILVER.

	£	s.	d.
Quicksilver	9	7	6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro silicon—	
25%	7 15 0
45/50%	13 17 6
75%	19 12 6
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free of Mo.	6/3 per lb.
Ferro-titanium—	
23/25% carbon-free	10d. lb.
Ferro-phosphorus, 20/25%	£17 17 6
Ferro-tungsten—	
80/85%	1/7 1/2 lb.
Tungsten metal powder—	
98/99%	1/10 1/2 lb.
Ferro-chrome—	
2/4% car.	£29 5 0
4/6% car.	£22 15 0
6/8% car.	£22 0 0
8/10% car.	£21 17 6
Ferro-chrome—	
Max. 2% car.	£34 10 0
Max. 1% car.	£36 5 0
Max. 0.70% car.	£40 2 6
70%, carbon-free	11d. lb.
Nickel—99.5/100%	£240 to £245
"F" nickel shot	£216 0 0
Ferro-cobalt	7/3 lb.
Aluminium 98/99%	£100 0 0
Metallic chromium—	
96/98%	2/8 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese—	
94/96% carbon-free	1/4 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under 1/2 in. to 1/4 in.	3d. lb.
Do., under 1/4 in. to 1/16 in.	1/- lb.
Flats, 1/2 in. × 1/4 in. to under 1 in. × 3/8 in.	3d. lb.
Do., under 1/2 in. × 1/4 in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Heavy steel	2	4	0	to 2	5	0
Bundled steel and shrngs.	1	17	6	to 2	1	6
Mixed iron and steel	2	0	0	to 2	1	6
Heavy cast iron	2	3	0	to 2	4	0
Good machinery	2	8	0	to 2	10	0
Cleveland—						
Heavy steel			2	0	0	
Steel turnings			1	12	6	
Cast-iron borings			1	3	6	
Heavy forge			2	10	0	
W.I. piling scrap			2	2	6	
Cast-iron scrap	2	2	6	to 2	5	0
Midlands—						
Light cast-iron scrap			2	0	0	
Heavy wrought iron			2	8	9	
Steel turnings, f.o.r.			1	6	0	
Scotland—						
Heavy steel	1	18	9	to 2	0	0
Ordinary cast iron			2	7	0	
Engineers' turnings			1	12	0	
Cast-iron borings			1	12	6	
Wrought-iron piling			2	5	0	
Heavy machinery	2	10	0	to 2	11	0

London—Merchants' buying prices, delivered yard.

Copper (clean)	21 0 0
Brass	16 0 0
Lead (less usual draft)	9 0 0
Tea lead	7 10 0
Zinc	8 0 0
New aluminium cuttings	74 0 0
Braziery copper	19 0 0
Gunmetal	18 0 0
Hollow pewter	80 0 0
Shaped black pewter	60 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	65/-
Foundry No. 3	62/6
,, at Falkirk	59/9
,, at Glasgow	62/9
Foundry No. 4	61/6
Forge No. 4	61/6
Hematite No. 1, f.o.t.	59/6
Hematite M/Nos., f.o.t.	59/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	68/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	62/-
,, No. 3 fdry.	66/-
Northants forge	58/6
,, fdry. No. 3	62/6
,, fdry. No. 1	65/6
Derbyshire forge	62/-
,, fdry. No. 3	66/-
,, fdry. No. 1	69/-
Scotland—	
Foundry No. 1	67/6
,, No. 3	65/-
Hem. M/Nos. d/d	66/-
Sheffield (d/d district)—	
Derby forge	59/6
,, fdry. No. 3	63/6
Lincs forge	59/6
,, fdry. No. 3	63/6
E.C. hematite	75/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	67/-
Staffs fdry. No. 3	67/-
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	82/-
Clyde, No. 3	82/-
Monkland, No. 3	82/-
Summerlee, No. 3	82/-
Eglinton, No. 3	82/-
Gartsherrie, No. 3	82/-
Shotts, No. 3	82/-

FINISHED IRON AND STEEL.

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	9	0	0	to 9	15	0
Nut and bolt iron	7	10	0	to 8	0	0
Hoops	10	10	0	to 12	0	0
Marked bars (Staffs) f.o.t.			12	0	0	
Gas strip	10	10	0	to 12	0	0
Bolts and nuts, 3/4 in. × 4 in.			12	10	0	
Steel—						
Plates, ship, etc.	8	15	0	to 8	17	6
Boiler plts.	8	0	0	to 9	0	0
Chequer plts.			10	7	6	
Angles			8	7	6	
Tees			9	7	6	
Joists			8	15	0	
Rounds and squares, 3 in. to 5 1/2 in.			9	7	6	
Rounds under 3 in. to 3/8 in. (Untested)			6	15	0 & up.	
Flats—8 in. wide and over			8	12	6	
,, under 8 in. and over 5 in.			8	17	6	
Rails, heavy	8	5	0	to 8	10	0
Fishplates			12	0	0	
Hoops (Staffs)	9	10	0 & up.			
Black sheets, 24g. (10-t. lots)			9	10	0	
Galv. cor. shts. ,,			11	15	0	
Galv. flat shts. ,,			12	5	0	
Galv. fencing wire, 8g. plain			14	0	0	
Billets, soft	5	0	0	to 5	7	6
Billets, hard	6	12	6	to 7	2	6
Sheet bars	4	15	0	to 5	2	6
Tin bars				4	15	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	10 1/2d.
Sheet to 10 w.g.	11 1/2d.
Wire	11 3/4d.
Rods	10 1/2d.
Tubes	15d.
Castings	12 1/2d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1 1/2 to 1/7 1/4
To 15 in. wide	1/1 1/2 to 1/7 1/2
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2 1/2 to 1/8 1/2
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3 1/2
Ingots rolled to spoon size	10d. to 1/6 1/2
Wire round—	
to 10g.	1/4 1/2 to 1/11 1/2

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3 1/2 upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	13.34
No. 2 foundry, Valley	14.50
No. 2 foundry, Birm.	11.00
Basic	15.39
Bessemer	16.89
Malleable	16.39
Grey forge	16.39
Ferro-mang. 80%, seaboard	68.00
O.-h. rails, h'y, at mill	40.00
Billets	26.00
Sheet bars	26.00
Wire rods	35.00
	Cents.
Iron bars, Phila.	1.86
Steel bars	1.60
Tank plates	1.60
Beams, etc.	1.60
Skelp, grooved steel	1.60
Steel hoops	1.55
Sheets, black, No. 24	2.00
Sheets, galv., No. 24	2.60
Wire nails	1.85
Plain wire	2.10
Barbed wire, galv.	2.35
Tinplates, 100-lb. box	$4.25

COKE (at ovens).

Welsh foundry	20/- to 22/6
,, furnace	16/- to 16/6
Durham and Northumberland—	
,, foundry	21/- to 25/-
,, furnace	13/3
Midlands, foundry	—
,, furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	15/6 to 16/-
,,	28×20 ,,	31/- to 32/-
,,	20×10 ,,	22/3 to 22/9
,,	18 3/4×14 ,,	16/1 1/2 to 16/4 1/2
C.W.	20×14 ,,	14/6 to 15/-
,,	28×20 ,,	30/3
,,	20×10 ,,	22/-
,,	18 3/4×14 ,,	15/10 1/2

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6	0	0	to £7	0	0
Bars-hammered, basis	£16	10	0	to £17	0	0
Bars and nail-rods, rolled, basis	£15	17	6	to £16	5	0
Blooms	£10	0	0	to £12	0	0
Keg steel	£32	0	0	to £33	0	0
Faggot steel	£18	0	0	to £23	0	0
Bars and rods dead soft, st'l	£10	0	0	to £12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.	
Mar.	30 ..	28	2	6	No change
,,	31 ..	28	5	0	inc. 2/6
April	3 ..	28	3	9	dec. 1/3
,,	4 ..	28	1	3	,, 2/6
,,	5 ..	28	5	0	inc. 3/9

Electrolytic Copper.

		£	s.	d.	
Mar.	30 ..	32	5	0	dec. 5/-
,,	31 ..	32	5	0	No change
April	3 ..	32	0	0	dec. 5/-
,,	4 ..	31	15	0	,, 5/-
,,	5 ..	32	0	0	inc. 5/-

Standard Tin (cash).

		£	s.	d.	
Mar.	30 ..	150	12	6	dec. 2/6
,,	31 ..	151	2	6	inc. 10/-
April	3 ..	151	7	6	,, 5/-
,,	4 ..	152	0	0	,, 12/6
,,	5 ..	153	10	0	,, 30/-

Tin (English ingots).

		£	s.	d.	
Mar.	30 ..	152	0	0	inc. 5/-
,,	31 ..	152	10	0	,, 10/-
April	3 ..	152	15	0	,, 5/-
,,	4 ..	153	5	0	,, 10/-
,,	5 ..	154	15	0	,, 30/-

Spelter (ordinary).

		£	s.	d.	
Mar.	30 ..	14	16	3	inc. 2/6
,,	31 ..	14	17	6	,, 1/3
April	3 ..	14	7	6	dec. 10/-
,,	4 ..	14	8	9	inc. 1/3
,,	5 ..	14	8	9	No change

Spelter (Electro, 99.9 per cent.).

		£	s.	d.	
Mar.	30 ..	17	5	0	No change
,,	31 ..	17	7	6	inc. 2/6
April	3 ..	17	5	0	dec. 2/6
,,	4 ..	17	0	0	,, 5/-
,,	5 ..	17	0	0	No change

Zinc Sheets (English).

		£	s.	d.	
Mar.	30 ..	24	0	0	No change
,,	31 ..	24	0	0	,, ,,
April	3 ..	24	0	0	,, ,,
,,	4 ..	24	0	0	,, ,,
,,	5 ..	24	0	0	,, ,,

Lead (English).

		£	s.	d.	
Mar.	30 ..	12	0	0	inc. 5/-
,,	31 ..	12	0	0	No change
April	3 ..	12	0	0	,, ,,
,,	4 ..	12	0	0	,, ,,
,,	5 ..	11	15	0	dec. 5/-

AVERAGE MONTHLY PRICES OF FURNACE COKE D/D MIDDLESBROUGH.

Year	January	February	March	April	May	June	July	August	September	October	November	December	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1901	0 17 6	0 14 0	0 13 0	0 14 0	0 14 6	0 15 0	0 15 3	0 15 3	0 15 9	0 16 6	0 16 9	0 16 9	0 16 4½
1902	0 16 9	0 15 0	0 15 6	0 15 0	0 15 0	0 15 3	0 15 3	0 15 3	0 15 6	0 16 0	0 16 6	0 16 0	0 15 5
1903	0 15 9	0 16 0	0 16 3	0 16 9	0 16 6	0 16 3	0 16 0	0 15 9	0 15 6	0 15 0	0 14 6	0 14 0	0 15 8½
1904	0 13 9	0 13 9	0 13 3	0 14 3	0 14 6	0 14 3	0 14 3	0 14 3	0 14 3	0 14 0	0 14 0	0 14 6	0 14 1½
1905	0 14 9	0 15 3	0 15 3	0 15 3	0 15 6	0 15 6	0 15 6	0 15 6	0 15 6	0 15 6	0 15 9	0 17 0	0 15 5½
1906	0 17 6	0 17 6	0 17 0	0 17 0	0 17 0	0 16 6	0 17 0	0 17 0	0 18 3	0 18 6	0 19 0	1 0 0	0 17 8½
1907	1 4 6	1 5 0	1 5 0	1 0 6	1 2 0	1 1 0	1 1 0	1 1 0	1 2 0	1 1 6	1 0 0	0 17 0	1 1 8½
1908	0 16 0	0 16 0	0 15 6	0 16 0	0 16 3	0 16 0	0 15 6	0 15 6	0 15 6	0 15 3	0 16 0	0 16 0	0 15 9½
1909	0 16 0	0 15 3	0 15 0	0 14 9	0 15 6	0 15 9	0 15 6	0 15 6	0 16 6	0 17 0	0 17 6	0 17 0	0 15 11½
1910	0 18 4½	0 18 6½	0 18 0	0 18 0	0 17 10½	0 17 0	0 16 1½	0 15 9½	0 15 11	0 16 0	0 15 9½	0 15 8	0 16 11
1911	0 16 0	0 15 10½	0 15 6	0 15 3	0 14 9	0 14 6	0 14 6	0 14 6	0 14 6	0 14 11½	0 15 0½	0 16 3½	0 15 1½
1912	0 17 3	0 17 3	0 18 6	0 18 10	0 19 0	0 19 4½	0 19 10½	1 0 9½	1 2 9	1 4 1½	1 5 8½	1 8 6	1 1 0
1913	1 5 9	1 4 11	1 5 0	1 5 0	1 4 9½	1 0 4½	0 19 5½	0 18 3	0 18 0	0 18 2½	0 18 6	0 18 6	1 1 4½
1914	0 18 2	0 17 1	0 17 0	0 17 0	0 17 4	0 17 6	0 17 6	0 18 5	0 18 4	0 17 9	0 17 6	0 18 5	0 17 8
1915	0 17 10½	0 17 9	1 0 4½	1 7 7½	1 9 4½	1 10 7½	1 9 7	1 7 3	1 5 4	1 4 9	1 9 6	1 13 0	1 6 1
1916	1 10 9	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6½
1917	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 14 3	1 15 6	1 11 2½
1918	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6
1919	1 15 6	1 15 6	1 15 6	1 15 6	2 1 6	2 1 6	2 3 9	2 10 6	2 10 6	2 10 6	2 10 6	2 10 6	2 3 5
1920	2 12 3	2 14 0	2 19 0	2 19 0	3 3 8	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 2 6
1921	3 1 0½	2 19 0	2 16 0	2 7 0	2 6 6	2 6 6	2 0 6	2 0 0	1 13 11	1 12 9	1 10 4½	1 8 3	2 3 6½
1922	1 7 0½	1 8 1½	1 9 7½	1 8 4½	1 7 11½	1 7 3	1 6 9½	1 6 10½	1 7 0½	1 10 2½	1 10 0	1 9 11½	1 8 3½
1923	1 11 3	1 14 6	2 0 1½	2 2 8½	2 4 4½	2 2 10½	2 1 0½	2 1 6	2 0 9½	1 18 9	1 18 8½	1 18 3	1 19 7½
1924	1 16 6½	1 14 9	1 11 11½	1 10 0½	1 8 1½	1 7 8½	1 7 3	1 6 3	1 6 0	1 5 0	1 5 0	1 5 0	1 9 6½
1925	1 4 10½	1 4 1½	1 13 3	1 2 4½	1 2 2½	1 1 5½	1 1 3½	1 4 9	0 18 10½	0 18 4½	0 19 6½	1 1 4½	1 2 8½
1926	1 2 1½	1 0 9	0 19 2½	*	*	*	*	*	*	*	*	1 5 0	1 1 1½‖
1927	1 5 6	1 4 9½	1 6 1½	1 3 9	1 2 6	1 0 8½	0 19 4½	0 19 0	0 18 7½	0 18 0	0 17 10½	0 17 6	1 1 1½
1928	0 17 6	0 17 10½	0 18 0½	0 17 11½	0 17 8½	0 17 6½	0 17 7½	0 17 6½	0 17 6	0 17 7½	0 17 7½	0 17 6	0 17 8
1929	0 17 7½	0 18 0	0 19 0	0 19 6½	0 18 10½	0 19 10½	1 1 3½	1 1 8½	1 3 0	1 3 6	1 3 8	1 3 1½	1 0 9½
1930	1 2 6½	1 1 3	1 0 3	0 19 1½	0 17 7	0 16 10½	0 16 6	0 16 9	0 16 9	0 17 0	0 17 0	0 17 0	0 18 2½
1931	0 17 0	0 16 7½	0 16 0	0 16 0	0 15 11	0 15 5	0 15 1	0 15 0	0 15 0	0 16 9	0 17 0	0 16 6	0 16 0½
1932	0 17 0	0 16 11½	0 16 5½	0 15 9	0 15 7½	0 15 6	0 15 6	0 14 9½	0 14 6½	0 14 6	0 14 6	0 15 4	0 15 6½
1933	0 16 0½	0 15 9½	0 15 6½	—	—	—	—	—	—	—	—	—	—

* Strike period. ‖ Five months.

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(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

LARGE FRENCH FOUNDRY COMPANY requires the services of a Specialist able to install and supervise the manufacture of centrifugally-cast piston rings. The firm would buy licence for manufacturing.—Replies to Box 384, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

REPRESENTATIVES required in Scotland, Lancashire, North East Coast, Midlands, South Wales and London for sale of Foundry Plant and general Requisites; commission basis only; state full particulars and area covered.—Write Box 380, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

STEEL FOUNDRY FOREMAN required by Works specialising in heavy and medium castings; experience of Siemens Furnace (Acid) Process essential.—Applications giving full particulars of experience and salary required, to Box 382, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of The Foundry Trade Journal.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

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PATENT.

PATENTS relating to Improved Processes for Manufacturing Grey Cast Iron. The Proprietors of British Patents Nos. 247,941, 260,619, 260,990, 262,043, 275,646, 291,112 and 341,436 wish to sell the patents or to license British Manufacturers to work thereunder.—Address: A. Boshart, Stuttgart-Cannstatt, Ludwigstr. 42 (Germany).

TENDER.

METROPOLITAN WATER BOARD.
TENDERS FOR THE SUPPLY OF STORES, Etc.

THE Metropolitan Water Board invite tenders for the supply of the under-mentioned stores and services, etc., for periods of 6 and 12 months commencing June 1, 1933:—

Tender No.	
1	Bricks, firebricks, cement, etc.
8	Iron and steel.
9	Bolts and nuts, screws, files, shovels, steam tubes, etc.
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19	Iron, brass, gun-metal and other castings.
20	G.M. stopcocks and ferrules, outlets and caps for fire hydrants.
22	Timber.
23	Maintenance of weighing machines.

Tenders must be submitted on the official forms, which may be obtained on and after Monday, April 3, 1933, from the Chief Engineer, by personal application at the offices of the Board (Room 155) or upon forwarding a stamped-addressed envelope (large).

Applicants should refer to the number of the tender for which forms are required.

Tenders, enclosed in sealed envelopes, addressed to "The Clerk of the Board" and endorsed in the manner indicated in the form of tender, must be delivered at the offices of the Board (Room 122) not later than 11 a.m. on Friday, April 21, 1933.

The Board do not bind themselves to accept the lowest or any tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
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March 30, 1933.

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PUBLICATION.

RYLAND'S DIRECTORY of the Coal, Iron, Steel, Tinplate, Metal, Engineering, Hardware and Allied Trades. 1932 edition. Price 42s., bound in cloth.—Industrial Newspapers, Ltd., 49, Wellington Street, Strand, London, W.C.2.

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